A Monthly Popular Journal of Knowledge

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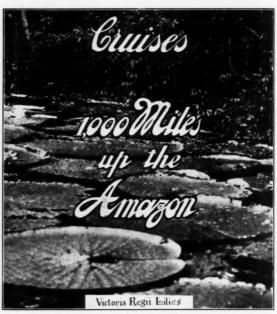
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DISCOVERY

A Monthly Popular Journal of Knowledge

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Editorial Notes.

THOSE who had the privilege of hearing the Prince of Wales deliver the presidential address to the British Association at Oxford last summer, will remember that in moving a vote of thanks on that occasion Lord Balfour ventured to prophesy that the year of royal office would be marked by an event of outstanding scientific importance. Probably few of those present had definite knowledge as to what Lord Balfour was referring, though most of them must have thought of some possibility or another. It was therefore a happy occurrence that the Prince, when speaking at the annual dinner of the Institution of Electrical Engineers last month, was able to mention a particular achievement that had given, to use his own word, a "hall-mark" to his term of office-the bridging of the Atlantic by wireless telephony. Yet even the public interest in this historic event was hardly comparable to that aroused by former discoveries.

"When one reads of the excitement that was aroused by the opening of the first Transatlantic cable," said His Royal Highness, "it seems surprising how calmly everybody has accepted this wonderful achievement of being able to call up the United States. Science can triumph over time and space."

If it is perhaps inevitable that each new discovery must attract less attention than its predecessor, this tendency is at least indicative of the ever-increasing confidence which scientific research inspires.

A leading article some weeks ago in Nature dealt with the question of "Science and the Press." The

view was expressed by our contemporary that having regard to the increasing tendency of the newspapers to include regular articles on scientific developments, written in popular language, there is room for a daily or weekly newspaper devoted exclusively to material of this character. It need not be said that any project for the extension of popular interest in knowledge has our whole-hearted support; and since the article related to a field in which Discovery is doing pioneer work, its purport was of the greatest interest to us. In our experience there are two chief obstacles to be overcome in the production of popular reports of technical matters. Firstly, there is the impossibility experienced by many of the most distinguished scholars of expressing themselves in language "understanded of the people"; no less is that of the journalist in grasping the significance of the material he is handling so as to achieve the balance of emphasis that is essential if his report is to be of any value -a striking instance of this difficulty being the subject of a letter in our correspondence columns this month. There is, secondly, the time factor, which in the presentment of news of any character is of the utmost importance. Most researchers-even supposing their ability to write in popular terms-are necessarily so occupied with preparing the official report of their results while these are fresh, that they have little leisure for a task which to be successful requires considerable labour. Even monthly publication scarcely affords the necessary time; and while many contributors to Discovery spare no efforts to record their discoveries at the earliest moment, it will be no surprise to readers that many important articles are arranged for several months before they actually appear in print.

While we frequently refer in these columns to the difficulties of providing a journal to suit the individual tastes of our wide circle of readers—which, by the by, is now approaching ten thousand in number—it is not often that the opportunity arises of gauging the extent to which interest attaches to a particular feature. Some interesting facts are, however, forth-

coming from the article on ladybirds, appearing in our Christmas number. Research on these insects is beginning to be undertaken in this country, in view of their importance to horticulturists as destroyers of green-flies; Mr. Marriner described how experimental breeding can be carried out, and suggested that his remarks "might point the way to set about this research." No invitation to correspondence was included, yet in less than a month after publication the author had received nearly sixty letters of serious inquiry for further information, including communications from highly specialist investigators in this country and abroad. The point we wish to emphasize is that one of the many discoveries recorded in these pages- we are sure entomologists in general and Mr. Marriner in particular will pardon us for saying on a subject of so little apparent significance as the smallest of beetles !- was, in fact, such up-to-date information that it naturally elicited this spontaneous interest. It is pertinent to disclose-for which we must ask the author's further forgiveness-that so overwhelmed was he by this deluge of letters that he sent us an urgent request not to give his address to any further applicant. As a matter of fact, we had not given it to any of his inquirers, who must therefore have obtained his whereabouts from the Entomological Society's list. Judging from personal weakness, we can only suppose that the number who would have written but did not go to the trouble of securing this reference was very much larger; it may also be deduced that these correspondents contained a high percentage of specialists, who follow Discovery as a matter of course for the latest information.

* * * * *

Perhaps the most interesting section of the second report on the vocational guidance experiment which is now being carried out by the National Institute of Industrial Psychology with a grant from the Carnegie Trust, is that describing the following-up of the careers of the children who have so far been advised as to the work to which they appeared to be most adapted. This was begun some months ago, and while it is too soon to attempt a detailed analysis, the results, so far as they go, are stated to be encouraging. Of 161 children who have been followed up successfully, 103 (sixty-four per cent) are in work of the same or similar kind as that recommended, the majority of these being in their first post. Only four have had more than two posts, and there are no cases in which dissatisfaction with the work has been definitely expressed. Though this does not imply that none exists, comparison with those doing work of a different kind is significant in this connexion.

It was found that 18 children—or thirty-one per cent of those in this class—have definitely expressed dissatisfaction either with the work or the prospects, and there are 10 children who have changed their work from three to eight times in less than a year. These results are generally in agreement with those obtained in a former inquiry, and may be considered to be distinctly promising. As, however, they concern only the children examined by the Institute, the outcome of an inquiry yet to be made into the corresponding rate of change among the children who were not examined will be awaited with much interest.

* * * * * *

The figures now issued were obtained from information gained through a visit to each child's home. The carrying out of these visits, entailing as they do interviews with parents which are difficult to conduct, especially in the case of children who have not received the Institute's examination and advice, has drawn attention both to the chance circumstances affecting this method, and to the unreliability of the information so obtained. It was therefore felt that the opinion of an independent observer, such as the employer, would be of greater value, and the help of the Ministry of Labour has now been secured in the matter of interviews.

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Professor Julian Huxley, in the recent Norman Lockyer lecture of the British Science Guild, stated that temperament is largely an affair of the balance of the various glands of internal secretion-thyroid, pituitary, reproductive, adrenal, etc., and it may well be that the applied physiology of the future will discover how to modify this factor. Many men of sedentary life who came back from the war with altered temperaments had probably, to use Cannon's phrase, "discovered their adrenals"—the violent activities into which they were forced made demands upon these and other glands that their previous life had never done. The glands responded by increase of function, a new equilibrium was set up which was preferred to the old, and consciously or unconsciously their mode of life became adjusted so that it was continued on a different plane. "We are sure to discover more and more of the means of playing on this complex system within us and eliciting from it the vital harmonies which we desire," Professor Huxley concluded. Greater knowledge of physiology, too, will doubtless enable us to stimulate our faculties when we need high-tension work, but without evil after-effects, and likewise to relax them without the use of harmful soporifics.

Researches on the Mental Factor in Birds.

By C. J. Patten, M.A., M.D., Sc.D.

Professor of Anatomy, Sheffield University.

By a series of fascinating experiments and observations here described and illustrated by his own photographs taken from life, the author shows the way in which interesting evidence of the extent and power of bird mentality may be discovered. Professor Patten's previous article dealt with the flight factor.

APPROACH quietly and as closely as possible one of our small familiar birds, say a chaffinch, perched on a branch of a hedgerow; note that his bright sparkling little eyes immediately meet your gaze. Stir slightly (even a change of facial expression such as lifting the eyebrows will suffice), and off he goes. Approach a rat in a locality where he is not persecuted unduly, say at the edge of a stream or as he forages amidst garbage on the sea-beach. See! he is aware of your presence; he has stopped feeding and his snout moves rapidly from side to side while he keenly sniffs the air. A slight stir or even "pulling faces" will not disturb him. His sight is not concentrated on you, and he will not take fright as long as you do not make a noise or, by coming too close, smell too human. These simple but important observations tell us that we have before us creatures with different types of brain, namely, the "eye-brain" of the bird and the "nose-brain" of the rat. External impressions for the most part pour into the brain of the bird through its sense of vision; in the rat (and such holds good in the case of the generality of mammals), mainly through the sense of smell. Obviously then mental faculties in bird and rat have evolved along different lines. The bird may not be classed as intelligent as the rat or other mammal from the standpoint of evolution; phylogenetically its brain is less developed. In other words, the bird occupies a lower position zoologically than the mammal.

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Emotions.

However, if we admit that intelligence in the bird has not advanced so far, there is not the slightest doubt that the emotional side has outstripped that of the mammal. This becomes evident when we witness the intensely elaborate passions in avian love and courtship, which far exceed any such thing exhibited in mammals. The remarkable development of the emotional side of bird mentality also stands out prominently in connexion not only with song in the strictly technical sense, but also with manifold call-notes, battle-cries, and other vocal utterances which are so incessantly produced as to render many species decidedly loquacious. The rhapsody of the

song-thrush, poured out without intermission for hours at a stretch, is a stupendous expression of mental emotion. Whilst song expresses emulation, rivalry, and address to the female, nevertheless it cannot be denied that it is also an expression of hilarity. The frantically wild and heated tournaments, indulged in by some male birds in the breeding season, are also indicative of intense exuberance of life. Sprightliness of deportment abounding in grace, elegance, and activity; high spirits; taste for the beautiful; curiosity, attention, sympathy, benevolence; and responsiveness to man's advances, when confidence has been gained, are well marked traits in bird mentality. Here, indubitably, are tokens not only of pure emotions, but also of general intelligence. But it is in their wonderfully acute powers of observation, correlated with an equally wonderful acute memory for places and things, that birds furnish evidence that they are endowed with a well-developed and specialized brain.

Likes and Dislikes.

Birds evince strong likes and dislikes for different persons and other creatures. Nor is the imaginative faculty wanting when they grow puzzled at strange forms not only of living but also of inanimate objects. One of my tame kestrels flew at my dog when first they met; soon, however, they made fast friends, so much so that the bird often jumped upon its companion's back or head, where she would remain perched contentedly, especially if a black cat, which she hated, came in sight (Fig. 3). That same little falcon failed to recognize me if I approached her when wearing a hard felt black hat; she became restive and fearful; why, it seems difficult to say, but she may have vaguely conjured up in her mind some creature with a formidable black beak (the rim of my hard hat), by means of which she might be speedily dispatched! Possibly she may have associated the black colour of my harmless head-dress with that of the swarthy feline lurker. Or again, in this guise I may have represented an effigy in her mind of some object which she may have seen on a former occasion and to which she had taken a violent objection.

In regard to memory, I am convinced, after making many observations and having collected a considerable amount of data, that this primary mental factor is highly developed in birds. Memory for places may first be considered. By closely studying the habits of birds, and by carrying out careful anatomical and physiological investigation in regard to their visual sense, we learn how it is that memory has become so highly developed. Migration is the rule among birds, and their visual sense, especially their wonderfully keen perception of form, helps them to memorize the position and contours of mountainranges, river-sheds, and other features en route. In that way they learn to establish geographical landmarks. Further aid is afforded by their tremendously long range of vision. Migrants become quite cegnisant with vast tracts of sea-board and, so to speak, "hug the coast" whenever it is possible. Let me again emphasize the fact that the eye is everything to the bird—the mainstay of its brain, the sheet-anchor of its life. Instinct alone will not explain how it is that migrating birds are enabled to seek out their destinations. If their landmarks become eclipsed, if their coastline melts away in the inpenetrable gloom, the travellers often wander seawards or drop down to inhospitab'e islands or rocks, where they may be held up without food or water. They may be placed in this most awkward predicament for some days. Moreover, even in clear weather a proportion of the less experienced travellers do habitually go astray. Many of the so-called rare casual visitors to our coasts are simply vagrants which have lost their way. These birds usually occur in abundant numbers along their normal migration routes. Speed and endurance on the wing, linked up with special qualities of vision (notably long and penetrating range and keen perception of form), give the keynote in regard to the remarkable faculty birds show for memorizing places. In popular parlance then we would say that birds have a "good bump for tocality."

Visual Sense.

Some birds, notably members of the crow family, have a habit of hiding articles which they surreptitiously purloin. Burial is resorted to when soil is available. When we remember that the olfactory sense in birds is recessive, it must be admitted that the restoration of such stolen goods implies a considerable associative memory exercise. It is much easier to understand how it is that a dog could return to the site of his buried bone and then exhume it; he could track it down by his keen scent.

The definite and continuous scent-trail allows of a simpler associative memory exercise. I recall an experiment made in my schooldays. Two pet jackdaws were each presented with a broad bean, marked differently. The birds buried their booty almost at the same moment in a flower-bed. Five hours later each jackdaw, when again liberated in the garden, secured his treasure without hesitation, the beans having been buried at a distance of only six feet apart. Here the visual sense, so highly specialized, may have enabled the birds to take note of little landmarks which we would have altogether overlooked.

Nest-Construction.

It would be difficult for man, with his stupendous mental equipment, to put himself mentally in the place of the bird. He would find it very hard to conceive of such faint and flash-like avian consciousness: of such rapid and undeliberated judgment; of such feebly flickering powers of abstracting ideas; and of the still more feeble and flickering powers of mental reflection. Nevertheless, after patient and close observation, mental actions have been revealed on the part of the bird which, not only because they are variants of the normal, but more particularly because they indicate evidence of judgment (elemental, of course, we admit), undoubtedly pass beyond the bounds of stereotyped instincts. Such avian mental plasticity affords a fascinating branch of ornithological research. Let me here support the argument by briefly citing a few concrete cases which have come under my own personal notice.

Nest-construction affords an admirable field for research. Departure from type within limits is not uncommon. Such fluctuations usually point to lack of finish, either through exigencies of circumstances or through lack of practice and experience on the part of juvenile builders. On the other hand, nests which present variations so pronounced in character as to render their recognition on first examination difficult, though much rarer, do actually occur. To proceed: for some years the hedgerows had not been controlled by the clippers, consequently wide-spreading branches and dense foliage afforded suitable nestingsites for chaffinches and other familiar species. Now it so happened that in the particular year in which I found a most remarkable nest of a chaffinch, the hedgerows in the neighbourhood had been very closely pruned, and from a holly-bush a few of the main branches had been neatly sawn off. On the sawn flat surface of one of these branches a pair of chaffinches started building operations.



Fig. 1.

THE ROCK-PIPIT'S SANCTUARY.

Dashing into a covered corridor this rock-ripit escaped the clutches of a merlin. Profiting by this experience it made it a practice to repair to this sanctuary directly its enemy was seen in the distance.

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surface of the holly-stump only by feathers and wool. In other words, the foundation of the nest, composed of mosses and lichens, was represented simply by a deep rim. The wren builds a domed nest, oval in shape, with an entrance hole in the centre. In a crevice of a turf-bank I discovered a wren's nest, cupped shape, i.e., quite open at the top. The overhanging ledge of turf served as the dome. Very often the lapwing makes no pretence at nest-construction. It will

deposit its eggs in the foot-print of a cow or in some other shallow receptacle. Sometimes, however, a lapwing will scrape a slight hollow with its beak or it will deepen one already discovered. Lining material is seldom used, but I have found grass-stems roughly arranged under the eggs, no doubt for the purpose of rounding off sharp projecting stones and other pronounced inequalities. We marvel at these feats of engineering, but at the same time must guard ourselves from judging by human standards of mentality. At most we can surmise that if birds can be conscious in themselves of their doings and can pass judgment on them, such mental activities are but a faint copy of those which the human brain is capable of calling forth.

All of us know that our familiar song-thrush repairs to a special stone, against which he smashes the shells

knows that the chaffinch builds neat cup-shaped nest. Here, mirabile dictu, the bottom of the cup was not constructed at all. SO that the breast of the bird brooding separated from the cut

of snails. We should call this an intelligent act; so it is, but it is none the less instinctive. This is shown by the fact that all song-thrushes adopt the same measure without tuition. At most an immature inexperienced bird may not succeed in his first trial or two, but as the predisposition to break shells is inborn, success must follow surely and without delay. What student of marine bird-life is not familiar with the markedly intelligent performance which the herring-gull displays when he lifts a mussel, cockle, or other shell-fish to a height in his beak, and then suddenly releases the mollusc over a rock against which he expects it to break when it makes contact? Instinct we say again, forsooth, for all herring-gulls, without tuition, indulge in this habit to procure the

contents of the shell. I have seen over a score of these birds arranged in a long line all busily "shell-fish dropping."

Many instincts are the very embodiment of high intelligence; the results achieved are often so elaborate as to put many reasoning faculties the shade. Professor Ewald Hering launched a true criterion when he said: " Man certainly finds it difficult to acquire arts of which the lower animals are born masters." Here is, however, an interesting variant. I observed herring - gull a



FIG. 2.

THE KESTREL'S CONTEMPLATION.

"Will another mouse peep out to-day?" Having alighted by chance on a tree-stump, when a mouse happened to peep out below, for a few successive days this tame kestrel regularly watched from this same perch.

capture a rat and then aloft. The rodent was let fall on a rock but was not killed. The performance repeated twice over, yet the rat survived. The fourth time the gull, rising on high, bore off its victim seawards and,



Fig. 3.

LIKES AND DISLIKES.

The kestrel sought protection by alighting on the head of its canine friend when the hated black cat approached.

dropping it in the water, swooped down and rested for a minute or two alongside. The rat being played out, swam with difficulty, albeit the gull was too cautious to close upon it at once. It was not until the animal was all but drowned that it was of a sudden engulfed headforemost. Now this herring-gull was alone, and it probably grew perplexed as to how it should proceed. Hence the cautious measure which it adopted with its struggling quarry. A party of herring-gulls (even if composed of a small number), would have instantly finished off the rat between them, and then a fight would have ensued for the possession of the carcase. Bigger creatures than rats have met their end in a similar way at the "hands" of these avian pirates! The solitary herring-gull which undertook to deal with a rat as though it were a shell-fish, in the first instance failed, and then deliberately tried a new measure by dropping it in the water and allowing it almost to drown. Surely that gull showed in the performance of this act undoubted forethought and judgment.

Intelligence.

One more instance before I close. My tame kestrel alighted on a dead tree-stump. A mouse peeped out below. Like a flash the hawk was on its prey. For a few successive days the bird regularly alighted on the tree-stump and watched intently for another mouse (Fig. 2). However, as the pigmy rodent failed to reappear the strategic hunt was soon abandoned. Now the wild kestrel, as a rule, hovers at a considerable height above the ground when searching for its prey. Therefore the method adopted by my tame bird of waiting on a branch near the ground was a new departure, nor had it been induced by practice or repetition. Doubtless, the hawk rapidly associated the idea of perching on the tree-stump with seeing and capturing a mouse. But superadded was the feeling of expectation which arose in the bird's mind, shortly to be replaced by the feeling of disappointment. Here at least some power of abstracting ideas is indicated, although these mental processes no doubt were based mainly upon associated ideas. Hence a distinct element of the faculty of reasoning can hardly be denied.

Birds, speaking generally, are distinctly responsive. Many species are readily tamed by kindness and attention to their wants. We can see this being brought out best in our garden species which are afforded the more opportunities of human intercourse. Nevertheless, at the sound of the handle of the knife striking a plate, I have tamed gulls to assemble at my feet after a flight of some little distance from the

sea. They learned to respond to "the dinner gong." But the varying degrees of responsiveness, considered not only collectively among different classes of birds, but also in regard to individuals of the same species, is a matter of surpassing interest in the study of bird mentality. For instance, at a given signal (a weird vocal one of my own making), all the sparrows in the party which I have tamed assemble at my doorstep for breakfast, three cross the threshold and enter the room, and of these, two alight on a chair, but only one is daring enough to perch on the table and join me at breakfast. All birds of the party have had the same individual attention bestowed upon them, but the result of their education has not proved uniform. Anyone who takes on the task of taming birds soon finds out that his pupils vary appreciably in temperament, and are even prone to show at times special little idiosyncrasies. Summing up, it may be said that birds as a class are bright intelligent creatures, and in proportion to their brain development and relatively high position in the zoological scale they can certainly profit by experience up to a certain extent (Fig. 1). Indeed, their specially endowed "eye-brain" seems in some directions to give them an intellectual pull over some of the orders of lower mammals. It is very interesting to remember that birds on the one hand are so highly specialized that plasticity for further mental progress is checked, but on the other hand their highly developed visual sense has allowed of, and indeed is intimately correlated with, the development of vivacious, pleasing, and aesthetic characters, common to man himself. Consequently human and avian friendship have become most affectionately cemented. No small wonder then in the fantasy of the "Transmigration of Souls" birds, before all other creatures, were the recipients of sanctification.

Hostels for Poor Boys.

A NEW movement on behalf of boys in destitute or undesirable circumstances in the East End of London was inaugurated on 23rd February, when the John Benn Hostel and Milner Hall was opened by H.R.H. the Prince of Wales. This building constitutes a memorial to the late Sir John Benn (founder of Benn Brothers Ltd., publishers of *Discovery*), who for many years represented Stepney in Parliament and on municipal bodies; and to the late Lord Milner, who at the time of his death was president of Toynbee Hall. The hostel will house about ninety working boys, and it is hoped by the East End Hostels Association, which has been formed for the purpose, to found eventually other such institutions in the London slums.

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Cloud Photography for Amateurs.

By H. Rait Kerr.

The following account of cloud photography, and the remarkable illustrations accompanying it, are the outcome of original research by an amateur, who here describes how such results may be obtained with an ordinary camera and films. It has hitherto been considered necessary to use special apparatus for this work.

Though the air is undoubtedly the ideal locality from which to take cloud photographs, as is shown by the magnificent results that have recently been obtained by Captain A. G. Buckham, it is not easy of access to many of us. Fortunately, however, given a good horizon, it is possible with a reasonable expenditure of time and care to obtain good cloud pictures from the ground without the use of any very elaborate or expensive apparatus.

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Original Researches.

I should perhaps mention at the outset that when I first started cloud photography I knew absolutely nothing about it, but I have had very encouraging results, and it is with a view to interesting other amateurs like myself in this branch of photographic work that I write this article. The methods described are original, for as far as I know hitherto no one has made serious researches on taking clouds with an ordinary camera, using ordinary films. It has always been considered necessary to use special apparatus—a camera fixed in the ground in the same manner as an astronomical telescope, or special types of camera. Those who have photographed clouds from an aeroplane have also made use of cameras specially designed for this purpose or those of the reflex type. I conceived the idea of writing this article having received a letter from an authority on the subject, Captain C. J. P. Cave, who expressed surprise that I had obtained such good results.

The study of clouds, their formation, structure, and composition, forms a very interesting and indeed fascinating subject; their "scenery" is unrivalled and shows infinite variety from one moment to another, hence it is necessary for the cloud photographer to be very much on the alert if the finest effects are to be recorded. Spring and summer are on the whole the best seasons for this work, and very fine effects can then be obtained, if due attention is paid to perspective, although the results here reproduced were successfully taken in the winter.

Certain forms of clouds give better results than others: I have found I get the best pictures from cumulus and alto-cumulus, from "sunset clouds,"

cirro-cumulus, "mackerel" skies, strato-cumulus, cumulo-mimbus and from special types of cirrus, but the latter, especially high cirrus, with its delicate "lace" effects, is more difficult to achieve in any measure of success. Strong well-lit cloud masses will invariably give satisfactory results, provided the exposure is correct. No cloud is as effective as the towering cumulus with possibly what is known as an "anvil head," or again the thunder-clouds, piled mass upon mass until they look like mountain ranges.

There is little or no literature on the subject of cloud photography, with the exception of a few notes in photographic handbooks which deal with clouds as an adjunct to the landscape, but not as pictures in themselves. Mr. Clayden, in his book "Cloud Studies" (second edition, 1926), devotes a chapter to cloud photography which is very helpful, but he writes perhaps more from the standpoint of the specialist, and uses a more elaborate type of camera than most amateurs are likely to have at their disposal. His results are very fine, but at the same time it is possible to get good pictures on a smaller scale.

The Apparatus Used.

I use a quarter plate (pre-war) Voigtlander "Alpin" camera, with a Voigtlander Collinear III 12 cm. lens, working at apertures from f. 6.8 to f. 45, and having shutter speeds of half, 1-10th, 1-25th, 1-50th, 1-100th, and 1-250th sec. The camera has a rising front and double extension, which when the outer lens is removed gives a telephoto effect, but I have not so far found this latter feature very satisfactory for taking clouds, and its use complicates the question of length of exposure.

I have experimented with many makes of films (I do not use plates), and have had successes and failures with all of them; but I have come to the conclusion that the failures are more often due to the brain behind the camera than to the films used. I started with an ordinary Kodak film-pack used without a screen, and the first photograph (No. I on page 77), showing cumulus and high cirrus, is the result. I then tried the Kodak "Super-speed" flat film, using yellow filters with which I increased the ordinary calculated exposure by four or seven times.

Nos. 2 and 3 were done on these films. Panchromatic films appear on the whole to give the best results, but there is the great difficulty of loading and unloading the slides and of developing, each operation having to be done in darkness, and personally I do not think that they are quite as easy to work from the point of view of the average amateur, as the ordinary orthocromatic films used with a yellow screen. I hope to try the Imperial Dry Plate Co.'s "Non-filter" films to see what results I shall obtain with them.

Opinions differ as to exposure. I notice that Captain Buckham, in the January issue of The Camera, with which the air photographs already mentioned were reproduced, states:-"I am compelled to the conclusion that a rapid panchromatic plate is the best for the purpose." He is writing of photography from the air, and makes the following comments on his results :-

" It is often remarked that aerial photographs are much 'clearer and distinct' than those taken on ground level. The reason for this is that the belt of ground mist and haze is usually very shallow and frequently does not rise many feet from the ground, so that when one photographs, say, from an altitude of one mile, with the camera axis vertical to the earth, it is comparatively easy, with colour-sensitive plates and a filter, to diminish the veiling trouble considerably, or to cut it out altogether; but it is obvious that a man on the ground desirous to photograph some objects at a mile distant would be faced with a very different problem, for he would have to deal with mist and haze eight furlongs thick."

In calculating my exposures I have used either the special exposure calculator contained in the "Wellcome" Photographic Diary, or the Imperial Dry Plate Co.'s calculator when I have used their films.

Details of the Photographs.

Full details of the exposure, and other factors employed in taking the cloud photographs here reproduced, are as follows:-

(1) Taken with the camera front extended but without the use of a colour screen on Kodak film-pack. Exposure 1-50th second, stop f. 32; at 12.55 p.m. August, 1926.

(2) On Kodak "Super-speed" flat film, with Imperial Dry Plate Co.'s orthochrome yellow colour filter x4. Exposure 1-50th second, stop f. 6; 4.15 p.m., September, 1926.

(3) On Kodak "Super-speed" flat film, with Kodak yellow colour filter × 7. Exposure 1-50th second, stop f. 11; 11.55 a.m., October, 1926.

(4) Full expansion of camera. Kodak ordinary film-pack and yellow colour filter × 7. Exposure 1-10th second, stop f. 8; 4.30 p.m., 23rd October, 1926.

(5) Full expansion of camera. Kodak ordinary film and yellow colour filter ×7. Exposure 1-50th second, stop 3 p.m., 24th October, 1926

(6) Imperial Dry Plate Co.'s film-pack and orthocl yellow filter × 4. Exposure 1-25th second, stop f. 8; 3.15

(7) Kodak "Super-speed" flat film, with Imperial Plate Co.'s orthochrome filter × 4. Exposure 1-25th se stop f. 6; 4 p.m., 4th November.

(8) Imperial Dry Plate Co.'s "panchromatic" flat film orthochrome filter × 4. Exposure 1-25th second, stop

10.30 a.m., December, 1926.

It will be seen that the photographs were ta in the order as numbered, at intervals from Au to December of last year, Nos. 1, 4, 5, 6 being obta on ordinary film-packs, and Nos. 2, 3 and 7 on "s speed" flat films. No. 8, taken on a "panchroma film, is a satisfactory reproduction of very alto-cumulus clouds.

Methods of Procedure.

Mr. Clayden in his "Cloud Studies," alr referred to, writes: "Cloud photography, even of most delicate and brilliant varieties, is easy en when the right methods are followed; but thes not the same as those which are right for portra or landscape work of the usual kind." He goes recommend "a slow plate . . . Mawson Swan's photomechanical plates-extremely cau development and sometimes intensification of image are all that is necessary," and he also ad pointing the camera not at the cloud, but at an i of it formed in a black mirror. In a later ch Mr. Clayden gives us full details of his method procedure, and anyone contemplating cloud p graphy will find the information very useful. I perhaps add that I had not read his book nor in any hints on the subject when I began to photos clouds, but I subsequently received great help encouragement from Captain C. J. P. Cave, who done many cloud studies, some very beautiful e being reproduced in his "Clouds and We Phenomena."

As with most things, the best plan is for photographer to experiment for, himself and to and to go on trying until success is attained. Juat any rate by my own experience, it is not diff to be fairly successful in a comparatively short and I hope to obtain better results with fu experiments. Cloud photography is a fascing branch of study, both from a technical and an ar point of view, and to obtain really beautiful pic should not prove beyond the reach of anyone takes sufficient care and trouble.

Kodak ordinary film-pack re 1-50th second, stop f. 6;

m-pack and orthochrome cond, stop f. 8; 3.15 p.m.,

film, with Imperial Dry Exposure 1-25th second,

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best plan is for the or, himself and to try as is attained. Judging ence, it is not difficult aparatively short time, are results with further phy is a fascinating echnical and an artistic eally beautiful pictures reach of anyone who



SERIES OF CLOUD PHOTOGRAPHS TAKEN WITH AMATEURS' ORDINARY APPARATUS.

As described in the text opposite, where details of exposure and other factors are given, these beautiful effects were obtained by the author with an ordinary camera and films.

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SERIES OF CLOUD PHOTOGRAPHS TAKEN WITH AMATEURS' ORDINARY APPARATUS.

As described in the text opposite, where details of exposure and other factors are given, these beautiful effects were obtained by the author with an ordinary camera and films.

Inter-Glacial Man in England.

By J. Reid Moir.

Excavations in which the author recently took part near Ipswich have added considerably to our knowledge of the past history of man in Eastern England. The discoveries relate to the period of warm climate that intervened between the two great ice ages.

THERE are very few of us who are not interested in our remote ancestors who lived when the world was young. We want to know what they were like in appearance, the kind of lives they led, and the number of years that have passed since they disappeared from the face of the earth. These are somewhat difficult questions to answer, but modern archaeological research is

Valley Gravels Filled in hollow with Palaelithic flint implements

150 feet above River River Sea Level

Sea Level

Fig. 1.
THE SITE OF THE EXCAVATIONS.

Cross-section of the valley of the River Gipping at Ipswich, showing position of filled-in hollow, much exaggerated in size (where the finit implements were found), on the plateau. 1.—Glacial boulder clay. 2.—Ancient glacial gravel. 3.—Red crag (marine). 4.—Eocene clays and sands. 5.—White chalk (marine).

advancing with great and rapid strides, and the day when a complete answer to these questions will be possible draws ever nearer. There is perhaps no richer treasure-house of the relics of ancient prehistoric man in existence than the counties of Suffolk and Norfolk. When man made his debut into this area it was enjoying a tropical climate,* and it is in the deposits laid down during this salubrious epoch that crude and massive flint implements, the earliest efforts of human beings to flake stones intentionally, are found. But the warm and pleasant climatic conditions that ushered in the Age of Man were, in the course of time, brought to a close by the gradual onset of a glacial climate which, except for recurring inter-glacial epochs when the temperature temporarily rose, dominated the northern hemisphere for an enormous space of time. It was during the warm inter-glacial phases that man flourished in East Anglia, and the object of this article is to describe one of the ancient camping sites occupied by him between the second and third glacial epochs of that

The town of Ipswich lies in the wide Gipping Valley, and as we turn our footsteps eastward we ascend

* See "When Suffolk was Sub-Tropical," J. Reid Moir,

Discovery, October, 1926.

a long hill that takes us out of the valley on to the surrounding plateau. This plateau reaches to a height of about 150 feet above sea-level (Fig. 1), and exhibits generally a remarkable flatness, as though a giant steam-roller had passed over it, but we notice that at the place to which we are wending our way there exists a slight hollow, a few hundred yards in width, and following approximately a northwest-south-east line. The position of this hollow upon the plateau, and its relationship to the main valley of the River Gipping, will be clearly understood by reference to Fig. 1, and it will be realized that the size of the hollow has been much exaggerated in the drawing in order to enable the reader to fully grasp its significance and general form. This illustration (Fig. 1) also shows the various beds through which the river has cut during the formation of its valley, and it may be mentioned that the earliest relics of

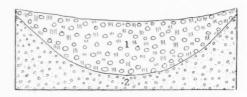


FIG. 2.

THE FILLED-IN HOLLOW DURING THE SECOND ICE AGE.
Diagrammatic drawing showing hollow entirely filled with boulder clay laid down during the Second Glacial Period of East Anglia. 1.—Glacial boulder clay.
2.—Ancient glacial gravel.

man in East Anglia are found upon an old land surface which existed in the remote Pliocene period beneath the Red Crag (Bed No. 3), shown in the drawing. Fortunately, some years ago a brickfield was opened at the spot where the hollow in the plateau to the east of Ipswich is situated, and the diggings then carried out exposed a number of sections which revealed a very interesting geological and archaeological story. Since then on two recent occasions scientific excavations, in which I took part, have taken place on the site of the old brickyard, and have added considerably to our knowledge of the past history of man in Eastern England. We know now that the depression in the plateau marks the place where a

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long-buried channel exists, filled in with clays and sands, and that in these deposits occur numerous flint implements of inter-glacial man. It may, therefore, be of interest to trace briefly the history of this ancient buried channel.

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When the second glacial period of East Anglia was at its height a great ice-sheet occupied the country, and in the course of its forward movement sometimes scooped out channels in the underlying beds, filling them with what is known as Boulder Clay, an unstratified deposit containing many ice-borne rocks, and composed of the remains of the beds which the glacier took up in its advance. When the ice of this period retreated the channel must have presented an appearance as shown in Fig. 2, being filled completely with Boulder Clay. The falling back of the glacier front indicates that the temperature was rising, and the results of this would soon show itself in the more or less rapid melting of the ice-sheet and the consequent setting free of vast quantities of water. This water in its wild rush to sea-level would follow, in most cases, the old lines of drainage, and it evidently did so in the case we are considering, for now only a remnant of the Boulder Clay is left at the bottom of the channel (Fig. 3). At this period there is good reason to believe that the channel in the plateau was by some means transformed into a lake, and such a sheet of water would afford a drinking place for game of all sorts. Thus we can imagine this site as a very happy hunting ground for ancient man, and there is no doubt that this supposition is correct. Lying immediately upon the surface of the Boulder Clay at the bottom of the channel (Fig. 3) is to be seen a bed of reddish sandy loam and shingly gravel, in which no traces of man have been found but, in the overlying deposits, composed of brick-earth and sand, his implements have been found in considerable numbers. The period in which these implements were made is known as that of St. Acheul (a place in France where this

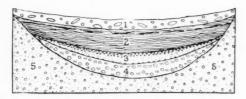


Fig. 3.
AT A LATER PERIOD STILL.

Diagrammatic drawing showing hollow re-excavated in the lower boulder clay, and filled in with palaeolithic deposits, which are sealed in by a bed laid down during the Third Glacial Period of East Anglia. I.—Glacial gravel, sand, and clay, much contorted, to 7 feet. 2.—Brick-earth series (containing dark bands of organic material towards its surface) with palaeolithic flint implements, except in its lower art, to 17 feet. 3.—Shingly gravel and reddish loamy sand, to 6 feet. 4.—Glacial dark grey boulder clay, depth unknown. 5.—Ancient glacial gravel.

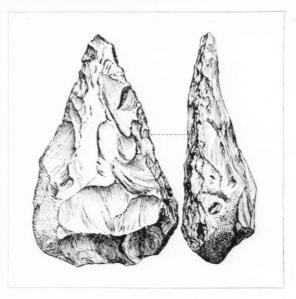


Fig. 4.

PREHISTORIC AXE DISCOVERED NEAR IPSWICH.

Such axes were either held by the thicker end or hafted in some way, and were probably the weapons of war of inter-glacial man.

particular type of specimen was first found), and the kind of man who made them is also known, for recently a remarkable human skull was found in a cavern in Galilee, associated with flint artifacts of the Acheulean epoch, and comparable with those discovered in the buried channel near Ipswich.

The human beings of this period had long low skulls, great projecting ridges over the eyes, prominent jaws, backward sloping chins, and walked with a somewhat slouching gait. But they were experts in flint flaking, as an examination of the illustrations accompanying this article will show. In Fig. 4 is depicted a typical axe of the period, which was either held by the thicker end in the hand or hafted in some way, and such as this were without much doubt the weapons of war and the chase of those far-distant days. obviously a knife is shown in Fig. 5 (2), and as newlyflaked flint has a razor-like edge, such a specimen with its rounded unflaked handle and suitably placed cutting-edge, would be capable of useful work in cutting up skins or in shaping bone and wood. A typical boring implement is illustrated in Fig. 5 (1), and specimens of this kind would be used for perforating various substances, or hafted and utilized as spear-heads. Thus we can conjure up a picture of these ancient Englishmen sitting by their camp fires, protected by primitive wind-shelters made of the matted branches of trees, and flaking their flints for the hunting expedition of the morrow.

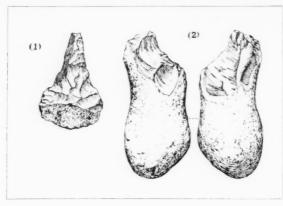


Fig. 5. (1) TYPICAL BORING IMPLEMENT AND (2) A KNIFE.

From the thickness of the deposits, some seventeen feet (Fig. 3), we may conclude that these people occupied this convenient camping ground for a prolonged space of time.

But gradually the climate once more began to degenerate, and the ever-lengthening winters, with rain and snow, and consequent floods, would, by insensible degrees, compel both animal and human populations to trek southward to warmer and more congenial pastures, and hunting grounds. The evidence of this oncoming of glacial cold is shown very clearly in the deposits filling the channel near Ipswich, because these are now sealed in by an accumulation composed of twisted and crumpled masses of sand, gravel, and clay (Bed No. 1, Fig. 3), which tells those who understand these things that for the third time East Anglia was over-ridden by an ice-sheet advancing from the cold and desolate north. This, then, is the graphic page of human history preserved to us in this filled-in channel in Eastern England, and those most familiar with the geological history of East Anglia have not much doubt that not less than 50,000 years separate us from the days when the Palaeolithic hunters made their camp by the side of the now silted-up and vanished Suffolk lake.

How Bees Come Home.

By Charlotte Haldane.

Research recently undertaken in Germany has led to interesting discoveries about bees, a number of ingenious experiments showing by what means they are able to find their way home after flights of long distances from the hive. Further light is also forthcoming on the fascinating problems of bee-psychology.

"Little Bo-Peep
Has lost her sheep,
And doesn't know where to find them;
Leave them alone
And they'll come home,
And bring their tails behind them."

THE apiarist has to play the part of Little Bo-Peep all the summer through. Yet this rôle does not disturb him. The "homing instinct" of bees is as commonly accepted as the migratory instinct of certain birds. We acknowledge the fact that the pollen or honey gatherers know their way home, and we think it no more wonderful that they return at eventide after flights of several miles, than the fact that we can find our way to our room in a hotel in a foreign city where we may be staying.

Nevertheless, the details of bee flight are most complicated and difficult bits of research, which have demanded extreme ingenuity and patience from those who have recently investigated them. A good deal of information has been obtained, and it is as interesting as the story of the worker's individual life and tasks, which I have described in previous articles.*

Professor Karl von Frisch, the great German authority who discovered the bees' methods of communicating with each other—or some of them—and who investigated their reactions to colours and scents, is responsible for some of the new facts which have been established. Others have been brought to light by experiments and observations made by Ernst Wolf.

The Sense of Smell.

Von Frisch found, as I have already told, that the bee's chief guide and means of communicating with her fellows was her highly developed sense of smell. If one of a group of workers discovered some recently opened blooms, such as roses, she would hurry back to the hive and dance on the comb. The others would endeavour to bring their feelers into contact with her abdomen, and the scent organs located in the antennae would note the particular perfume and would inform them which flowers to look for on their honey quest.

When the bee was fed with scentless sugar-water

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^{* &}quot;The Language or the Bees." "The Bee as an Individual." Discovery, March 1925, and May 1926.

she attracted her fellows by protruding a small abdominal pocket of glands, which sent out a strong odour recognizable by her friends. She did this while actually sipping, but only when there was more food than she could gather herself. When the supply became short she dealt with it singly, and did not emit the "scent-signal."

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The discovery of this scent-organ and its use left certain points to be cleared up. The experiments to prove its utility as a means of communication had only been carried out under artificial conditions, such as feeding on sugar-water laid on tables in a garden for the purpose. No bees had ever been observed to use the organ on other occasions. The explanation of this fact is a simple one. They only wish to attract fellow-helpers when there is a supply of food too abundant to be dealt with by themselves. During the daytime all the flowers in the neighbourhood of the hive would be so thoroughly examined and deprived of their nectar that there would hardly be an overflow. It might be that at dawn, when the first visiting bees would find the honey-cup filled overnight, they would make use of the scent-organ while collecting. But this had not hitherto been recorded.

Experiments at Munich.

In order to study the situation under different conditions von Frisch installed a small hive in the winter garden of the Munich Botanical Gardens. The bees soon became accustomed to the enclosed space, and began to take food and to visit the flowers growing in the hall. At the end of June the Robinia viscosa in the hall was in full bloom. It was visited by the bees who, however, were not seen to extrude their scent organ. When the flowers were taken to pieces no nectar was visible in them. A few branches were therefore picked, and put in water in a place inaccessible to the insects. After a few hours a drop of nectar was clearly visible in each flower-cup. The bees were then allowed to find them, and on doing so behaved in the manner already described. The early comers hurried back to the hive, carried out their informative dances, returned to the flower branches and stuck out their scent-organ while circling round them. When most of the harvest had been gathered the workers continued to finish the job, but no longer summoned other helpers to aid them.

Wolf observed the communicative use of the scentorgan in a different way. Attempts were made to mislead some bees by moving their hive from its accustomed position. When the first home-comers, after a certain amount of searching, found its new place, they would gather in an ever-growing crowd on the alighting board, all pushing out their scentorgans, until the "smell-signal" was powerful enough to reach returning late-comers. The speed with which the hive was discovered was proportional to the numbers producing the familiar scent, and as more and more workers found their way home, the guides gradually decreased their activities.

A Scent Problem.

The following interesting problem suggested itself to von Frisch. Is the scent produced by bees from a given hive specific to them, or has it similar attractions for all these insects? Does it have equal force as a signal to fellow-workers or merely to fellow-inmates?

To obtain a definite answer to this question was by no means easy. It required the following elaborate experiment:—

On a meadow in the Botanical Gardens, about six metres apart from each other, stood two hives, known as A and B. The experimenters arranged two feedingplaces, about two metres distant from one another, and seven metres from the hives. At one of them called "a" they placed watch-glasses containing honey on a yellow ground paper; "a" was at exactly the level, and to begin with, quite close to the alighting board of hive A. It was gradually pushed back farther and farther away from it, as the bees began to come regularly. Each bee coming to feed was marked and numbered. A watcher stationed by the hive controlled the returns. So after a time all bees coming to feed at "a" could be clearly identified as belonging to hive A; all intruders were killed, and in due course a group of feeders, all definitely known to come from hive A, were trained.

Exactly the same methods were then applied to hive B, except that workers from it were taught to feed from watch-glasses on a blue paper ground at a dinner table known as "b." Feeding was stopped at both places simultaneously.

Four people were needed to carry out this training experiment; at "a" all bees were marked on the thorax and abdomen with a spot of green colour; at "b' with a spot of blue. At each hive an observer called out the colour and number of the returning workers. The preparations took two days. On the third day there were at feeding-place "a" sixteen numbered bees from hive A; at "b" there were an equally identified number of regular callers from hive B.

The returning bees danced in both hives, and new customers came to both stores. The food was scentless sugar-water, so these new arrivals had no other guide than the odour provided by the scentorgans of their fellows. In view of the small distance between the hives it was to be expected that fresh visitors from A and B would visit both food stores in equal numbers—provided the message of the scent-organ was not specific to each hive.

The proportions of newcomers at the two feeding places were as follows (B being a larger hive than A):—

New visitors at Feeding Place "a:"
Friends Strangers 23 3 58 6

(I: 7.7) New visitors at Feeding Place "b:"
I riends Strangers 58 6

(I: 9.7)

These results made it quite clear that the scent produced at will by the worker bee is specific from hive to hive. The scent produced by a friend is more easily recognized than the scent produced by a stranger.

The next question which follows from the solution of this one is whether the scent from a strange hive would be effective if there were no scent from the home hive to compete with it? In order to clear this point, feeders from hive B had the segments of the abdomen, between which the scent-organ is protruded, painted over with shellac. This little operation made it impossible for them to signal with it. Feeding was stopped at both "a" and "b" and their positions were reversed. When the supply of sugar-water was renewed, eleven new visitors from hive B arrived at "b" where their scentless friends were feasting, and fourteen at "a," where competitors from hive A were as usual sending out the perfumesignal. There was therefore practically no differential effect which could be accounted for as recognition of the scent-message of any gathering worker bee by any other. So far the scent does seem to be specific to the hive. Both groups were of the same bee-race, the German, but were not closely related. Further experiments are to be carried out to see whether closer relationship modifies the results. Would, for instance, a group of swarmers in a new hive recognize the scent of the mother-hive after leaving it? Is the strange scent not smelt, or has it, when smelt, no attraction?

The Influence of Colour.

Before passing on to the description of a different set of experiments, one cannot help paying a tribute of admiration to the marvellous patience and delightful ingenuity of von Frisch and his fellow-workers. Quite as interesting is the work done by Ernst Wolf, to whom falls the credit of having discovered a mysterious direction-locating organ in the bee's feelers, which seems to have a function similar to that of the internal ear in mammals.

Both von Frisch and Wolf have established a fact

of immediate practical use to bee-keepers. A scent or a colour, or a combination of both, are valuable signposts when affixed to the hive. Owing to the bee's "colour-blindness" to red and green, these should never be used. White, yellow, blue, and dark grey are all very helpful colours. This point is important to the apiarist who keeps several colonies in one building, a kind of "bee-hotel." In such a case the entrances to the different hives housed under one roof can be painted in these contrasting colours much to the advantage of their frequenters. Such a bee-hotel can be seen from the train as it skirts the Lake of Thun in Switzerland, and is an impressive illustration of the benefits given to the practical honey-gatherer by the insect psychologist.

A curious phenomenon regarding the colour blue—one which, besides yellow, the bees recognize most easily, is mentioned by Wolf. If the hive-front is painted blue, the first home-comers are apt to hurl themselves against it, and to be thrown back on the alighting board. At the beginning of their training they mistake this sky-shade for free space, but they soon learn to identify it with their front door, and find it extremely helpful as a signpost.

Long Journeys from the Hive.

Now although scent and colour are useful guides to the worker when she is near enough to the hive to receive direct sense impressions, it is obvious that they are of no use when she is beyond their influence. Our own recognition of our home depends on sight in its vicinity, but when we wish to return to it from a long way we have to remember its position in relation to other objects, and also the turnings which we have to take to reach it. The bee appears to share with us this power of recognition and of memorizing. All of her expeditions, however, are made with the definite object of gathering either honey or pollen. It is therefore natural that when her path lies through woods or past buildings, owing to the tiresome ingenuity of experimenters who prevent her reaching the hive by an easier and more usual route, these obstacles will upset and sometimes irremediably perplex her. Bees taken away from the hive in boxes and then released, could find their way home from a greater distance in the open than from a smaller one surrounded by woods.

Rosch described most beautifully the orientation flight of the young worker who leaves her home for the first time. She never goes straight out as a honey or pollen gatherer, but takes several experimental flights to begin with, keeping quite close to the hive, with her antennae turned towards it, gradually fru
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extending the distance between herself and home, and wheeling in greater circles as she gains confidence. It is therefore not surprising to hear from Wolf that young bees taken away from home before they have made such experimental trips are, alas, invariably lost.

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The ability to find the way in the vicinity of the hive is acquired slowly and grows with the number of hours spent in flight. The circles of flight are described in such a way as to avoid obstacles and to include fruitful sources of food—moreover, a definite flight-path is followed with reference to certain fixed objects which serve as signposts.

In order to find out whether the bees were guided by any other factors in addition to sight and scent it was necessary to take them away from home-if possible to country quite unknown to them, and offering as few "signposts" as possible. Numbers of them were therefore carried off in little boxes to fields or commons some distance from the hive. As soon as the boxes were opened they crawled out and took wing, flying according to their custom in circles. It was discouraging for them. After a few flights they seemed to give up the attempt to get home and came back to settle in their boxes. But if the box from which a number of bees had started out was moved a short distance before their return, they did not attempt to settle on it-but assembled on the ground at the place where it had stood when they were released. They did not do this when the box was stood on a coloured ground which they knew, such as blue or yellow, or if it sent out some perfume with which they were familiar. Failing the guidance of colour or perfume, however, they had had to rely on their memory for the movements they had made, the angles they had described, when leaving the box. They apparently remembered—not leaving the box itself—but rising into the air from a special spot, and so, after their unsuccessful attempts to go home, they came back to this spot and not to their temporary home which they either did not find, or if they did find it, abandoned.

Discovery of a Guiding Organ.

This seemed to show that they possessed an organ to guide them in addition to those of sight and smell. But still more ingenious experiments were made before the point was proved and the alleged organ was located.

In a field with which the bees were quite familiar, a spot was chosen at a distance of 450 metres from the hive. Marked bees were caught at the entrance to their home and taken to this spot. They had been just about to alight after a day's work, and were

anxious to give up their honey. The starting-time from the given point and the time of arrival home were then noted, and in this way the time of flight for a given distance was recorded for seventy bees.

Another group was now caught in the same manner. But while they were being taken in their little cage to the "starting-post," the box was violently rotated, spinning them round and round. The turning appeared to make them giddy—just as human beings are made giddy by waltzing; their sense of direction was interfered with in some way, and in consequence their homeward flight took definitely longer than the journey of those on whom this practical joke had not been played. The fact was proved beyond doubt by using the same bees alternately for each experimental race. Even after ten or twenty minutes the effects of the rotation had not worn off.

Experimental Proofs.

It seemed clear therefore that the bee does possess a power of orientation which can be disturbed by rotating her. It was assumed that she could react to the turning in such a manner as to be made giddy by it. Wolf therefore argued that if an organ were found which was affected by the rotation, and if the bee were deprived of it, then there should be no difference in the time of flying home between normal bees and rotated bees minus this organ.

Now in the former group of experiments, when bees had been taken far from home in a box and then released, it has been told how they invariably arose, circled about, gave up the effort to return to the hive, and came back to settle on the spot whence they had started, whether the box was left there or not. Welf decided to find out whether a bee, if she had no feelers, would behave in this experiment like her normal sister or not: Would she try to settle on the spot where the box had been, or would she go to the box itself, that had during her absence been moved? Hardly one bee without feelers ever came back to the spot where the box had been when she If she noticed the box in its new position she would within a very short time return to it. This did seem to show that the feelers, or organs contained in them, play some very special part with regard to direction finding.

In flying from her little box the bee performs a certain number of curves and turns. As she is in a strange country she endeavours soon to return to the point whence she started. She does this by means of an organ which "registers" these curves and turns. The experiments with the feelerless bees seem to show that when the antennae are cut off they

are deprived of this organ, and must therefore rely on optical signposts, which lead them not to their point of departure—but to the box as soon as they have perceived it.

These conclusions were fully borne out by trying the rotation experiments on bees without feelers. As soon as the bees were deprived of their feelers, the rotation had no more effect on the time it took them to reach home from a given point. They had lost the power to be bewildered by rotation—and the organ on which this power seemed to depend must be located in the feelers.

This organ has not yet been examined, but the evidence from the experiments described seems to show that it corresponds in function to the semicircular canals which exist in the internal ear of vertebrates. It is not generally recognized that our ears are necessary to us, not only for hearing, but for keeping our balance. In the internal ear are three pairs of semi-circular canals which contain fluid. When we turn our heads the fluid in these does not at first move with the head, and presses on sensitive organs connected with the brain by nerve fibres. Owing to the impresses coming from these organs we automatically make righting movements with the limbs when falling, and move our eyes so as to keep the direction of gaze fixed when the head is turned.

The giddiness we experience if we spin ourselves around violently (as in the old-fashioned waltz), is due to the fluid continuing to spin after we have stopped. There is therefore a close parallel between our conduct when the unfamiliar movement ceases—our inability to walk straight or to direct our steps in the way we wish to follow—and the symptoms which the bee shows when she is released from the box in which she has been rotated.

In this connexion it is interesting to note that tests for aviators now include experiments to discover whether the semi-circular canals of the candidate are functioning normally.

Birds whose semi-circular canals have been destroyed are quite unable at first to stand, fly, or remain in any definite position. Yet after some months the disturbances are reduced and they learn to guide themselves by sight alone. If the analogy between the semi-circular canals and the guiding organs in the feelers of bees is correct, it is to be expected that bees deprived of their antennae would still be able to fly, by guiding themselves by the senses of sight and smell; but that they would have great difficulty in finding their way home whenever they were too far away from the hive to reach it with the help of these senses alone.

This is, briefly, the story of the bee's flight. It materially advances our knowledge of the habits of an insect which we may be glad to look on as our "little sister." As an illustration of scientific means of investigation on the one hand, and of the extraordinary and complicated ingenuity of Nature on the other, it cannot fail to give pleasure to all thinking human beings.

Authenticity of Architecture.

Mr. J. A. Gotch's paper "Inigo Jones: A Modern View," read to a recent meeting of the Royal Society of Literature, introduced a method of deductive reasoning which might prove to be a dangerous weapon in inexpert hands. The lecturer set himself the task of reviewing the works attributed to Inigo Jones and questioning their authenticity on the ground that the original drawings of these works are, in many cases, not by Inigo Jones himself, but by his very able pupil John Webb. Inigo Jones, who died in 1652, left a large collection of drawings, including studies of the figure and of drapery, and many designs for theatrical costume and scenery. These have been carefully preserved, and examination of them reveals the fact that comparatively few of the architectural ones are his own handiwork. Mr. Gotch throws no doubt on the attribution to Inigo Jones of the Banqueting House in Whitehall, part of Greenwich Palace, the Piazza of Covent Garden, now much altered, and St. Paul's, Covent Garden, which was rebuilt on Jones's original lines after it had been destroyed by fire, but he did much to undermine the faith of his audience in the case of other buildings with which the name of Inigo Jones is traditionally connected. He concluded his paper with a plea for facts to confront those which he had deduced: mere opinions on such matters were, he said, of little or no value. This is true enough, but it must be remembered that facts of this particular kind may easily lure less experienced investigators than Mr. Gotch to false conclusions. We have no idea how much of the huge mass of drawing required for St. Paul's Cathedral, for instance, would be found to be actually from Sir Christopher Wren's pencil. Few architects in wide practice-and Inigo Jones was a very busy man-can do more than suggest by preliminary sketches the general idea which is to be carried out by assistants skilled in their particular style. The keen iconoclast might even go so far as to attempt to prove that Mr. H. G. Wells did not write "The World of William Clissold" because the typewritten manuscript was not in his handwriting.

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Wanted: A New Biography of Ovid.*

By Arthur L. Wheeler, Ph.D.

Professor of Latin in Princeton University U.S.A.

A study of some problems confronting the classical scholar who attempts to improve the biography of Ovid shows how, contrary to rather widespread opinion, such biographies have not yet assumed a settled form.

In the light of recent discoveries a new account of the poet's life is required.

THE attempt to write the biography of an ancient author involves the consideration of problems and the use of methods which are fairly typical of a

whole group of subjects in which classical scholars are interested-those subjects, namely, which have been pondered for hundreds of years on the basis of evidence in which there has been very little change. It is the aim of this paper to illustrate the nature of the work upon such a subject by discussing certain aspects of the life of Ovid- a few aspects only, since my aim demands that each shall be treated in some detail.

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The ancient evidence from which the scholar must build up his biography of Ovid consists almost entirely of passages in the poet's own works, or in the works of other Roman writers. Lest I clutter up these pages with the apparatus of philology

I shall omit references to the evidence, and shall present it for the most part in translation or paraphrase. It is old evidence. A bit of it, supplemented by a good deal of imagination, was used in the brief Lives which were written in the Middle Ages. Beginning with the Renaissance the Lives grew longer and better, until they culminated in the elaborate work of Jean Masson in 1724. Masson's Life consists of ninety-one quarto pages, and contains almost every scrap of the ancient evidence. It is still valuable, although to-day many of its statements

must be modified as a result of the progress of our knowledge during the last two hundred years. For progress has been made and, contrary to a

rather widespread opinion, such biographies as that of Ovid have not vet assumed a settled form. Threshing old straw is from time to time worth while if. as in Ovid's case, there is considerable straw. new interpretations, new points of view-by any method which may elicit improved results from old evidence—specialists are constantly striving to solve old problems, or at least to bring them nearer to a solution. Often the result of many successive efforts to solve a given problem is-nothing. But one never can tell. Occasionally a real contribution is made, and after a series of years the sum of these contributions is considerable. This encouraging would fact

become clearer if we could compare a good biography of the poet written twenty or thirty years ago with a similarly good one recently composed, for the recent book would be decidedly superior to its predecessor.

But, unfortunately, there is at present no really good biography carefully based upon the ancient sources, adequately representing those sources, and embodying the approved results of the scholarship of the last thirty or torty years. Many outlines there are, a few of them good, but most of them disfigured by serious errors which are chiefly the results of careless statements and the use of second-hand material. I have collected a surprising number of these errors, and it would be both enlightening and



THE CORSO OVIDIO IN SULMONA, OVID'S BIRTHPLACE.

The author describes a visit to this interesting town, which is far from the beaten path of travel.

^{*} A lecture delivered at Princeton under the title "Threshing Old Straw," and here reprinted with illustrations from the *Princeton Alumni Weekly*, to which journal and to the author full acknowledgment of copyright is due.

amusing to discuss them, but I have space only to say that some of them are really pernicious because they occur in the mostly widely used handbooks—for example, the classical dictionaries. Anybody who will read the ancient sources can easily sweep aside the majority of these errors, but few readers have time for this. The good outlines, such as the one in the "Encyclopedia Britannica," are pretty free from mistakes, although most of them are now antiquated. But all the outlines have the common defect of omitting for brevity's sake many things of great interest; they give a wrong idea of the extent of the information which is contained in the sources. . . *

But the mere presentation of the evidence, no matter how full and interesting it may be, does not satisfy the scholar. He is more interested in the problems—in trying to make clear what was not clear before, rather than in stating what was already clear. In the biography of Ovid this means, as has been said, that the scholar must try to secure better results from old evidence. Like the tutor in Petronius, he is in constant danger of "teaching more than he knows," but if he is careful and alert, he may succeed in adding a bit here and there to our knowledge. The character of this work may be illustrated by considering one or two problems connected with chronology.

Chronological Discrepancies.

The biographies of Ovid differ remarkably in the degree of attention which they pay to chronology. Most of the outlines contain almost no dates. At the other extreme, Masson arranges his Life in the manner of a chronological table, and tries to ascribe every event to a definite year. Furthermore, the biographies vary a great deal in the actual dates which they assign for the same events. It is of interest to know, for example, the date of Ovid's first public appearance as a poet, but if we look into the biographies we find this event dated variously from 23 B.C. to 18 B.C., when the poet was from twenty to twenty-five years old. The reason for this wide disagreement becomes apparent the mome c we study the two most important passages which give a clue to the date.

The first clue is found in "Amores" III, 9, a poem on the death of Tibullus which must have been written soon after that poet died in 19 B.C. This is the earliest datable reference in the "Amores" and, since the

poems on Corinna, which belong to the "Amores," first brought Ovid fame as a poet, many scholars have dated his literary debut in 19 B.C., or a little earlier. But the second passage is far more important since here Ovid himself uses a phrase which will yield a pretty exact date-if we can be sure of our interpretation. Curiously enough his words take us into the sphere of the barber shop. "When first I read my youthful verse in public," he says, "my beard had been cut but once or twice," and the lines immediately following prove that this youthful verse consisted of some at least of the "Amores." Ovid evidently believed the reference to his beard to be a phrase which would indicate rather precisely how old he was at the time of his first public recitations, for the poem ("Tristia" IV, 10), in which these words occur, was written expressly to give posterity some information about himself. Unfortunately, not even his prophetic vision of his fame was far-reaching enough to include the ages in which his readers would no longer be Romans, and so we must discover as best we may just how a Roman would have understood this phrase.

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For centuries scholars have thought that Ovid was referring to the ceremony called depositio barbaea depositing and dedication of the beard in the shrine of the household after the youth had shaved for the first time. If, then, the age at which this ceremony occurred could be demonstrated, Ovid's phrase would have a definite meaning. But apparently there was no fixed age; Caligula was eighteen when he "deposited" his beard, Nero was twenty-two, Octavianus twenty-four. This explains the varying dates for Ovid's literary debut. Scholars have tried to harmonize the earliest reference in the "Amores," 19 B.C., when Ovid was twenty-four, with one of the ages at which the ceremony might occur. The results were not satisfactory, because Ovid was certainly a very precocious poet, and there is something a priori improbable in the view that he did not become known as a poet until he was twenty-four or even twenty. Moreover, why should he say "once or twice" when to the best of our knowledge the ceremonial shave occurred but once?

A New Interpretation.

Not long ago an interpretation was proposed which leads to a better result. It was noticed that when Ovid says "cut," he uses a general word (resecta) which does not necessarily mean "shaved"; in fact, the same word in another poem certainly means "trimmed," "clipped." This suggests that he is not referring to the first shave, but to another custom

^{*} To illustrate this point Professor Wheeler here dealt fully with the topic of Ovid's education and rhetorical training, as presented by the English biographer, S. G. Owen, in the Introduction to his edition of the *Tristia*, Book I, and by the fuller account from the writings of Ovid himself and of the elder Seneca, on which this particular outline is based.

which was common at least as early as Cicero's time—the custom of allowing the first beard to grow, trimmed in Vandyke fashion, until the time for the ceremonial shave arrived. Cicero calls the young fellows who wore such facial ornaments barbatuli, "the chaps with little beards," in contrast with the older men who were clean-shaven. In accordance with this interpretation Ovid means that his beard had been "trimmed but once or twice." In other words, if he was normally birsute—and he must have been normal since he uses the phrase to indicate his age—he was but seventeen or eighteen years of age

when he recited his first poetry in public, 26 or 25 B.C. This result is in harmony with Ovid's youthful bent for poetry, and it is not in conflict with the earliest reference in the "Amores," since the composition of these poems certainly extended through a number years and we cannot be sure that one of the very few that can be dated the epicede on Tibullus-is also one of the earliest to be composed. Ovid says that the poems which he first recited dealt with Corinna. Some of these. therefore, antedated the poem about Tibullus, and the fact that the latter now stands in the third book may hint that it was not one of the earliest pieces.

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The mention of Tibullus recalls a recent effort to improve our knowledge of Ovidian chronology by a method which differs from that which I have just described. Both poets were elegists, both were intimate with Messalla, and they were contemporaries, Tibuilus being the older by five years or more. It may be possible, by comparing the lives of two poets who had a common patron and at least some common interests, to bring certain facts into such relations that they will take on a new meaning. Thus we may learn a little more about both poets.

From what has already been said it would be natural to assume that Tibullus and Ovid must have known each other well. It comes as a surprise, therefore,

to find Ovid saying, as he recalled the poets whom he knew in his youth, "greedy fate did not allow Tibullus time for friendship with me." Since Tibullus died in 19 B.C., when Ovid was twenty-four, Ovid clearly means that but for that untimely death there would have been an opportunity for friendship after 19 B.C. But why had they not become friends before that date? The inevitable answer is that there must have been circumstances which prevented a friendship. By examining the lives of the two poets it is possible to find such circumstances.

In the four years 31-27 B.C. the two poets could

hardly have become friends, for Ovid was then only a schoolboy and Tibullus was absent a very large part of the time campaigning with Messalla. In the autumn of 27 B.C., however, when Ovid was sixteen, Messalla celebrated his campaign over Aquitania and Tibullus was probably in Rome, for he wrote an elegy in honour of the occasion. At this time then, or a little later, the two poets may have met, although definite proof is lacking, but Ovid's words quoted above prove that they could not have been more than acquaintances. Friendship (amicitia) was for the Romans a word full of meaning.

Between 27 and 19 B.C. there is only one fact of

which we can be absolutely certain that would have hindered him from becoming intimate with Tibullus: for two or three years he was busy as an official until he abandoned this career about 20 B.C. There remains the question raised by his journeys abroad which scholars have been unable to date with any accuracy. He was certainly in Asia when he was quite young. He was in Athens as a student, and this fact also suggests, though it does not prove, that he was young at the time. He passed the greater part of a year in Sicily, but his account of this sojourn gives no clue to the date. The view generally held has been that these absences occurred after he left school, which was the customary period for such journeys, and



STATUE IN THE COURT OF THE COLLEGIO OVIDIO.

Though discovered in Sulmona and locally believed to be a statue of Ovid it is probably not older than the Middle Ages.

this would mean that he was away from Rome for some two years altogether between 27 B.C. and 23-22 B.C. It is still impossible to determine whether these journeys were parts of one long trip or were separate, but the need for finding some reasonable explanation of Ovids failure to know Tibullus intimately lends support to the view that he was abroad within the period 27-23 B.C., the very years in which he might most easily have known him.

On the other hand Tibullus, like Vergil, was a great lover of the country and, again like Vergil, he may have disliked to live for long periods in the city. Moreover, there is good reason to believe—and the situation under discussion supports the view—that in his later years he was the victim of a melancholia which caused him to live much in retirement. This would have been an effective bar to the formation of new friendships. Thus the effort to explain why Tibullus and Ovid were not able to form that friendship which the younger poet so earnestly desired, results at least in strengthening the view that both were absent from Rome during considerable parts of a rather restricted period.

There is no inscriptional evidence bearing directly upon Ovid's lite. There are, however, inscriptions which throw some interesting sidelights on his name and racial antecedents, and quite recently one has been discovered which will probably alter somewhat our chronology of his later poetry. Most of these inscriptions come from the region of his birth, and so I may combine my discussion of them with a brief account of a visit which I made in 1922 to the poet's native place. Such accounts are very rare, for the town is so far from the beaten path of travel that not many even of Ovid's devotees have visited it.

Ovid's Birthplace.

"Sulmo is my native place," says the poet at the beginning of his autobiography, "rich in cold streams, nine times ten miles from the city." It is the modern Sulmona, almost due east of Rome, and it is well worth a visit if only for the reason that it lies close to some of the loftiest Apennines in one of the most beautiful regions of the world. Ovid's statement of the distance is accurate enough for a poet, but, as a matter of fact, the ninetieth Roman milestone was discovered in 1899 some miles west of the town, so that the journey by road was somewhat more than ninety miles, as it is to-day by railroad. The train winds about the mountains and plunges through dozens of smoky tunnels, but the traveller is amply compensated for the discomforts of the slow journey by the charms of the scenery, especially when the lovely vale of Sulmona comes into view, filled with the green of fruit trees and vineyards, and flanked by mountains which a few miles to the east tower more than eight thousand feet above the sea. Ovid loved his native place, often mentioning it in his verse, and his countrymen have requited his love by honouring the poet who truly prophesied that he was destined to be the glory of the Paelignian race. R

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A Disputed Statue.

The main street of Sulmona is the Corso Ovidio, the chief school bears on its front the words Regio Ginnasio Ovidio, and Collegio Ovidio, and against the wall of its court is a statue with the words *Poeta Ovidius Naso Sulmonensis* carved upon its base. The hands of the figure hold an open book, on the cover of which are the letters S.M.P.E., an abbreviation of the poet's words *Sulmo mihi patria est*. These same letters have indeed become a sort of municipal emblem used on documents and on the facades of public buildings.

The statue, which is less than life-size, is unfortunately not an authentic likeness of the poet, although the natives will tell you that it is antica. Ovid refers to portraits of himself on rings, but no genuine portrait of any sort is known to-day. This statue was discovered in Sulmona and is probably not older than the Middle Ages, but it testifies to the vitality in the town of the Ovidian tradition. Additional testimony is found in the belief that the foundations of the poet's town house lie beneath one of the churches, and that the Roman ruins two or three miles to the north on the steep mountain-side are called the Villa Ovidio. Not far from these ruins is the Fonte d'Amore, with which the poet's name is connected in the folk-lore of the region for, like Vergil, he became a great magician, and the peasants still sing old songs about him. All this concerns, not indeed the poet's mortal life, but that life which he prophesied for himself in the hearts of men-that posthumous fame which Professor Rand has recently traced through the ages in his book, "Ovid and his Influences."

The inscriptions of the region throw some light upon the Ovidii if not upon this particular Ovidius. Sulmo was one of the chief towns of the Paeligni, who were one of the numerous peoples of the Italic stock to which the Latins also belonged. Ovid says that his race was Paelignan, and that his family was of ancient equestrian rank, and it is interesting to find that the name Ovidius, as the rather numerous inscriptions show, was common only in the region of Sulmo. On the other hand, the poet's cognomen Naso, which has caused fancy portraits to be made depicting him with a nose a la Cyrano de Bergerac, is apparently Latin, and may indicate that there was a Latin or

Roman strain in the family. This conjecture is supported by the fact that from his boyhood Ovid was intimate with the great Roman house whose head at that time was Marcus Valerius Messalla, one of Augustus' ablest supporters. In some way the future poet must have secured the entrée to that house, and the most probable theory is, since at the time of Ovid's birth (43 B.C.) cognomina had not been long used in the mountain districts, that his father also or perhaps his grandfather had relations with the Messallae. Through this connexion there may have been a marriage between an Ovidius and a lady of Latin or Roman blood, together with a sufficient residence in the lowlands to establish the cognomen, and this Ovidius may have been the man with the big nose. But all this must at present be mere conjecture. The inscriptions name many Ovidii, but no Ovidius Naso. It is not known that any inscription preserves the name of a member of Ovid's immediate family.

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In the vale of Sulmona to-day the traveller may gaze upon much that the poet saw—the bare but splendid mountains, the clear streams, the garden-like cultivation of the valley floor. Probably in Ovid's time there was more timber on the hills and so more water in the streams. The isolation of the town must have been greater, but even to-day it is rarely visited by tourists and I wondered, as I reckoned up my expenses, whether the cost of living was relatively as low in Ovid's time as it is now. . . .

The work on Ovid's life moves slowly forward. The results are not spectacular, they cannot be absolutely proved, but many of the small puzzles have been cleared up or at least rendered more intelligible, and so our knowledge of the poet's life as a whole has been improved. It is time for some scholar to gather all the best results of this detailed work and write a biography which will be at once reliable and abreast of the times.

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- The Biology of Population Growth. (Willams & Norgate, Ltd. 10s. 6d.).
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- Lectures on Theoretical Physics. By H. A. LORENTZ. (Macmillan & Co. 12s. 6d.).
- Thought and the Brain. By Henri Pieron. (Kegan Paul, Trench, Trubner & Co. Ltd. 12s. 6d.).
- Population Problems of the Pacific. By Stephen H. Roberts. (George Routledge & Sons Ltd. 21s.).
- On Music's Borders. By SIR RICHARD TERRY. (T. Fisher Unwin (Ernest Benn). 15s.).

Wireless for Whalers.

Progress with New Apparatus.

Among recent innovations that have brought about great changes in modern methods of whaling, wireless telephony is of outstanding importance, and a number of Antarctic whalers, fitted this season with wireless telephone apparatus, have been enabled to spread further afield and to adopt tactics in finding and killing whales which would be impossible without this means of inter-communication. If one of the vessels so equipped sights a number of whales, perhaps

after two or three weeks' searching, it can immediately inform the other ships in the same fleet by telephone, so that all these can make for the best place for hunting. The "factory. ship" that accompanies the whalers can also be directed to the most suitable position for taking charge of the catches. By a simple system of code words the vital information in any message can be kept secret from other ships which might be within range.

The half-kilowatt telephone sets now fitted to all the ships of the Southern Whaling and Sealing Company, and to other whaling fleets,

have been specially designed by the Marconi Co. for this class of work, and are enclosed in steel cases which render them practically undamageable. Their operation is so simple that it may be carried out by a harpoon-gunner in full kit, the apparatus being worked by a stout lever which can be easily manipulated even when the hands are heavily gloved. Reception is by loud speaker, so that there is no need to remove head coverings in order to use the telephone. The efficiency of the standard sets may be judged from the fact that messages from the floating whaling

factory "C. A. Larsen" have been heard 2,000 miles away by the whaler "Sir James Clark Ross." Normally communication is maintained between whalers and with the whaling station at Stroemness, South Georgia, up to distances of 700-750 miles.

In addition to wireless telephones, a number of Antarctic whalers, including the British "Southern King" and "Southern Queen," were also fitted this season with direction-finders specially arranged for use on these small craft. In regions close to the magnetic pole, where much of the whaling is done, the magnetic compass is of little use and the wireless direction-finder, which is entirely independent of the

earth's magnetism, has been found invaluable to the whaling vessels. Like the telephone sets, these directionfinders are operated by the harpoongunner, and thus require no extra crew.

Wireless equipment has not only increased the hunting of efficiency the whaler fleets, but has greatly reduced the possibility of such dangers as isolation and loss of bearings. Two seasons when a whaling fleet made a speculative venture into the Ross Sea, which is enclosed by an ice barrier with only one seasonal outlet, the movements of the whalers from

of the whalers from the mother ship had to be considerably restricted owing to the unreliability of compass bearings, and in spite of every precaution the fleet was nearly cut off at the close of the season owing to the difficulties experienced in locating the sole outlet. Notwithstanding these conditions, however, the number of whales caught was so encouraging that the vessels again invaded the Ross Sea the following season, and with the aid of direction-finders, with which they had meanwhile been equipped, the catch was among the most successful on record.



EXPLORERS FOREGATHER.

Mr. T. A. Joyce, deputy-keeper of the Department of Ceramics and Ethnography, British Museum, who described the excavations carried out at Lubaantun, British Honduras, in the January issue of Discovery. He is seen before his departure on a further expedition there some weeks ago, "listening-in" with Mr. Mitchell Hedges (seated), who had accompanied him on the previous occasion and recently gave a broadcast lecture on their experiences.

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The Non-Inflammable Film.

By H. J. Mallabar, F.R.P.S.

Following the formation last month of a company to exploit the newly-discovered non-inflammable film, we are privileged through the courtesy of the chairman, Sir Herbert Blain, K.B.E., to be able to publish the first details of its manufacture to be made public. The author of the following article is the inventor of the new product.

THERE are many problems, some of them extremely difficult, to be solved in manufacturing a photographic cinema film, starting with the cotton and carrying on through the successive stages before the final film is packed ready for delivery to the user. When one carefully considers the enormous amount of skilled work involved in the great number of processes it has to pass through, combined with the very high standard of precision that must be obtained in the regularity and thickness of the film base, the consistent standard grade and speed of the sensitized emulsion, and the freedom from mechanical or chemical defects, it is marvellous that it can be, and is, sold at such a low price—approximately three-farthings a lineal foot.

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Manufacture of Ordinary Films.

To make this ribbon of cine film the highest grades of gelatine from the animal kingdom, cotton from the vegetable kingdom, and silver from the metallic, are used in enormous quantities, so large that one can hardly conceive them. Yet it was only thirty years ago that this now enormous industry was founded by the invention of Paul's Theatrograph, following, a few years previously, the making of a celluloid film in continuous length by Eastman.

From then until now celluloid has been universally used as the film base, or support, and although stringent regulations are enforced where it is used, there remains a long record of disasters owing to its explosive and highly inflammable nature. In consequence, a vast amount of research work has been undertaken to produce a film that would be non-inflammable, and therefore safe to use in home, school, or theatre; and as there is at present no known substance that can replace cellulose for this purpose, work has been concentrated on the acetate of cellulose instead of on the dangerous nitro-cellulose.

Cellulose acetate, first discovered by Cross and Bevan, who took out the original patent for its manufacture, has not in the past been satisfactory. The earlier cellulose acetates, such as that of Cross and Bevan, were soluble only in chloroform—which nullified any commercial value they may have had—and it was some years later before Miles patented his process of making them soluble in acetone, a cheap and therefore commercially valuable solvent. Cellulose

acetate, however, did not make films equal to the nitro-, and if such films did not melt in the heat of the projector, they became so brittle that after running through the projector several times they broke so badly at the perforations as to be useless, in addition to which the cost of manufacture was considerably higher than for nitro-cellulose.

Another serious obstacle in using cellulose acetate was, and is, that only a limited few firms in the world can make it; of that few, only two or three can make a really good acetate, and as these firms make it for their own purpose, which as a rule consumes their entire output, it is difficult to obtain supplies in small quantities and impossible in the large quantities required for serious film manufacture.

To make a perfect non-inflammable film, therefore, one must be able to make for oneself a cellulose acetate not only of the very finest and regular quality, but of a nature possessing special properties for film. That is, having in view the fact that it is to be used for photographic film, the process of making the cellulose acetate must be one which produces an acetate eminently suitable for that purpose, in not only enabling a non-brittle film to be made, but at the same time a film that does not affect the delicate light-sensitive photographic emulsion which subsequently must be coated thereon, acetic acid having a desensitizing action on silver bromide.

Details of the New Process.

I may explain here that there is no difficulty in making a non-inflammable film—one has only to dissolve cellulose acetate in acetone, and cast it on a highly polished surface to dry in order to obtain it; a film so made, however, is useless without the additions that must be made to the above solution to secure the properties required. When this solution, of which obviously I cannot disclose the composition or method of manufacture, is made, and filtered, it is cast on a highly polished metallic wheel of large circumference, in such a skilled way that the film, when measured in any part of its length or its width of approximately forty-three inches, will not vary between the limits of 0.136 to 0.140 millimetres.

Such a film must never become brittle, it must not affect the silver emulsion, and it must stand heat without any signs of collapse. (The acetate film I have invented stands about 100 degrees Centigrade more than the nitro film before collapsing). It must withstand intense cold without crystallizing, must not stretch or shrink beyond the permissible limits in the developing, fixing and washing operations, and it must meet its nitro- rival in the matter of cost production.

When the roll of film is made it is slit down its centre lengthwise, giving two rolls of 55 centimetres width, and before this is coated with the light-sensitive gelatine emulsion, it must undergo one of the most difficult operations in its manufacture, namely, treatment in such a way that the gelatine will correctly adhere, as gelatine coated on celluloid or acetate of cellulose film will, when dry, peel off of its own accord. That there are many manufacturers of roll film, but a limited number of cine film, is due, among other reasons, to this problem of correct adhesion, as the method adopted by many manufacturers of making the gelatine emulsion adhere, whilst satisfactory for films other than positive cine film, is useless for the latter, and would render the film brittle.

Difficult as the problem is with a nitro- base, it is far more difficult with an acetate base. The film ribbon when running through the projector not only has to withstand an intense heat (so intense that if a nitro-film were stopped for one moment it would take fire), but it has to withstand the mechanical strains of the projecting apparatus; and as the co-expansion of the acetate base and the gelatine emulsion coated thereon are so different, something has to give way under the above conditions.

Now if the base is treated in such a manner that the gelatine coating is firmly welded to it, the gelatine coating, which under the intense heat becomes horny and brittle, will crack. It is also found that, although the gelatine film is very thin compared to the base, if these two are firmly welded together, and the gelatine

cracks, it will crack right through the base-support also, whether that support is acetate or nitro; and the films so made, however good the base is otherwise, will only have a short life in the projector. A state of adhesion must therefore be obtained in which the gelatine emulsion will adhere sufficiently to enable it to be developed, washed, dried, and handled without any sign of the two separating. Yet when it has to face the strain in the projector the gelatine emulsion must be free to "creep" on the surface of the base. This is a difficult matter, and I think very few have solved it with non-inflammable film.

After this treatment of the base, known as "subbing," the prepared film is coated with the light-sensitive positive emulsion, which must be brilliant, free from fog, and always of the same speed and gradation. After this operation it is dried, then slit to the standard width of $\mathbf{1}_8^3$ inches, and examined for defects; it is then perforated with sixty-four perforations per lineal foot, after which it is reeled and packed ready for distribution to the producers of the pictures with which we are all so familiar on the screens.

Up to the present no manufacturer in Great Britain has manufactured this cine film throughout, starting with the raw cellulose in the form of cotton. This state of affairs, however, will be remedied in the future, as soon as the makers of the necessary extensive plant required can deliver, and erect it. Then, and then only, can "all-British" pictures be produced, as, in my opinion, a picture produced by a British company with British capital and British artists is not an all-British film when the base itself and the labour in making it is carried out abroad. The new British product will be free from all the dangers of the celluloid film, and will thus open up many new fields for cinematography, especially for educational purposes.

Forty-Knot Liners: An Italian Project.

By R. S. Russell, B.A.

The professed intention of Italian enterprise to construct Atlantic liners designed to travel at forty knots should influence existing services and their present records, which are here discussed in relation to the new project and its possibilities.

According to a speech recently made by the Italian Prime Minister, the speed of our fastest Atlantic liners is to be surpassed in the near future by vessels capable of attaining forty knots. The construction of two such vessels, to be called the "Rex" and "Dux," having a gross tonnage of 35,000-40,000, is at present being contemplated by Italian shipbuilding

engineers, and will be the outcome of a new and secret invention in propulsive machinery. Nothing is as yet disclosed as to the type of engine, beyond the fact that a "system of power units" is to be employed, and vibration will be practically eliminated. Signor Mussolini further mentioned that only one class of passenger will be carried, and that the

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completion of such vessels will cause a revolution in ocean travel. New York will be brought within four days of Cherbourg and five days of Italian ports, and the voyage from Italy to Buenos Aires will be shortened to one of seven days!

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The Existing Services.

It will be interesting to see what effect the launching of these two boats will have, if this project materializes, on the Cunard and White Star lines which maintain the fastest ocean service in the world. Though there is nothing to prevent forty knots being attained by a ship of 40,000 tons, provided sufficiently powerful machinery can be installed without occupying an undue amount of space, there is the very important question of the fuel bill which will have to be met at the end of every voyage. It is this enormous expense which high speed entails that has compelled the Cunard company to be content with the present record of twenty-six knots, and which caused the Germans to drop out of the competition twenty years ago. The S.S. "Majestic" consumes 1,000 tons of oil fuel a day to maintain her average speed of twentythree knots by means of eight Parsons turbines, and though her tonnage of 56,551 is somewhat larger than that of the proposed Italian liners, an increase of speed of even one knot above this rate would mean an enormous increase in the fuel consumption. amount of fuel required is doubled when the speed of a boat is raised from twenty-two to twenty-six knots.

It was shown by the construction of the S.S. "Aorangi," of 18,500 tons, belonging to the Union Steamship Company of New Zealand, that a saving of £125 a day was effected by her internal combustion engines over a ship of similar size and speed propelled by steam turbines, but there is no motor ship in service of a tonnage greater than 25,000 by which comparisons may be made, and still less is there a vessel of this size capable of a speed of over thirty knots. Whether the new invention in Italian engineering will overcome the extra expensive fuel bill remains to be seen.

If these vessels cater only for passenger traffic and mails and carry very little cargo, as is the case with the British giants, the working expenses will entail a high passenger rate, failing financial assistance from the Italian Government. The minimum winter first-class fare by any of the fast Atlantic liners is somewhere in the neighbourhood of £55, and the mainstay of the passenger traffic is the large numbers of American tourists who flock over to Europe every year. It is a doubtful question whether these wealthy people will forsake the comfort and luxury of the Cunard and White Star boats for the faster Italian ships, if the accommodation of the latter in any way

falls short of the present high standard of these British vessels.

There are several companies which compete for the traffic to the Argentine, and there are possibilities of great developments in trade with this comparatively new country. The Royal Mail Steam Packet Co., the Royal Holland Lloyd, the Compagnie Navigation Sud-Atlantique, and the Hamburg-Sud-Amerika Line all maintain regular services between Europe and Buenos Aires, besides the Italian lines, and another British company, the Blue Star Line, has now been added to the list. The R.M.S.P. Co. are now bringing into their service the motor vessel "Alcantara," 22,500 tons, a sister ship of the famous "Asturias," which has now been in commission some months. As these British and foreign boats have an average speed of only fourteen-eighteen knots, a forty-knot service on this route would mean a great saving of time in the voyage from port to port. There is, however, a limit to the draught of vessels which can call at Buenos Aires, owing to the shallowness of the estuary of the River Plate. Extensive dredging operations would be necessary before any large vessel could be brought up to Buenos Aires.

The record for the Atlantic crossing has been held by the Cunard liner "Mauretania" for the past eighteen years, though her average of twenty-six knots maintained from Queenstown to New York in 1910 has been exceeded, since she was converted to burn oil-fuel, by a passage from New York to Plymouth at an average speed of 26.25 knots. Until twenty years ago the competition for speed was entered into by British and German companies. Since the war the latter have not been in a position to challenge the "Mauretania's" speed. The S.S. "Columbus" is the only boat of over 30,000 tons which has been laid down in a German shipyard in recent years, and her speed is limited to twenty knots. She was built to replace the White Star liner "Homeric," which was surrendered after the armistice. Some vessels of about 22,000 tons gross have been launched from German shipyards in the past few years, but nothing capable of a greater speed than twenty knots has been constructed since the "Majestic" was completed in 1922.

The Italians have recently built two 25,000 ton motor ships, the "Saturnia," and "Vulcania," one of 33,000 tons, the "Augustus," and a turbine vessel of 33,000 tons, the "Roma," besides some others which they have had constructed in a British shipyard. They have not hitherto, however, made any attempts to enter into the speed competition, and their prospective entry may be the beginning of a new era in ocean travel.

History from Antique Flowers.

By F. A. Hampton.

Since many of the flowers that have survived the centuries are florists' plants—selected and, in a way, created by the gardeners who grew them—there may be discovered from them something of the taste and fashion of their period. The cultivation of antique flowers as a hobby will be dealt with in a later article.

THE word "antique" has come down in the world since it described the stretched metre of an antique song, and has become a very worn and depreciated piece of currency. But, although the taste which it implies has been a little vulgarized and a good

deal exploited, there still remains something to be said for our characteristically English appreciation of the antique; for, in general, the best things of their kind have the best chance of surviving, and the possessions of our forefathers which have come down to us have usually been preserved for some intrinsic good quality or other. The presence, too, of these old things in our own familiar surroundings gives a sense of continuity with the past which is pleasant and perhaps of value to most of us, though it seems to irritate a few progressive and impatient spirits.

The appreciation of the antique has, unfortunately, become so

general and fashionable that the demand exceeds the supply, surprisingly ample though it be, and prices tend to soar out of all reason. Yet there is a class of old and beautiful things which has never attracted much attention from the collector and can never acquire a high market value. These are the antique flowers which were grown by our ancestors but, by some change of fashion, have drifted out of cultivation. Some are rare and difficult to come by, some are reputed extinct but probably exist in a few old gardens awaiting recognition, none of them is expensive. There is no fear that anyone who admires your double black wallflower or your old red Dusty Miller or silver-striped rosemary will ask how much you gave for it, for the answer will only range

> uninterestingly from ninepence to one-andsix, if the particular treasure were not, as most likely, a gift.

> These antiques have the great advantage over the ordinary kind that they can be easily multiplied. It is true that old furniture is susceptible of reproduction, even of what biologists the call " reproduction by division," but the process is not much encouraged; it is quite otherwise with the antique flowers, and their divisibility enables us to collect specimens from old cottage gardens with no trace of the twinge that any person, at all sensitive to congruity, must feel in lifting an old piece of furniture from its immemorial

THE BLACK MOSS ROSE.

The moss rose became very popular in early and mid-Victorian days, when many new varieties of it were raised from the old pink form, which had been introduced about the end of the sixteenth century.

setting. They can never appeal strongly to the collector, for the "unique specimen" is almost impossible and though here and there some perverse gardener may jealously guard a rarity believed unique, he can never be quite sure of its right to the title.

Most of these old plants are florists' flowers, selected and, in a way, created by the gardeners who grew them, so that they reflect something of the taste and fashion of their period. Just how much they reflect is a matter for speculation and some fancy, for it is

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difficult to crystallize the various tastes of an age into one formula, and easy to colour it with our own misconceptions. But most people will agree that the stiff symmetry of the double striped camellia matches the superficial formality that we associate with the mid-Victorian period, while its vigorous and bizarre colouring hints at another quality, perhaps equally characteristic of the age though less obvious.

The moss rose combines the prim and picturesque with the same effect, though less emphatically, and will appeal more to the collector, since it does not ask for the spacious setting of a Victorian glasshouse. Its popularity is as much early as mid-Victorian

(and it has shared in the recent revival of its contemporary fashions) for though it was introduced, probably Holland, about the end of the sixteenth century, it escaped much notice until the early part of the nineteenth, when it was taken up by florists and new varieties of it were raised. It is said to have been introduced into France by Madame de Genlis, and there it became immediately popular and seems to have developed a slightly more formal character than elsewhere, so that many of the French moss roses, such as the black "Nuits de Young" and the pink and white "Oeillet Panaché," have a certain air of elegant and conventionalized abandon. A slightly later period of French history is recalled by the fierce magenta

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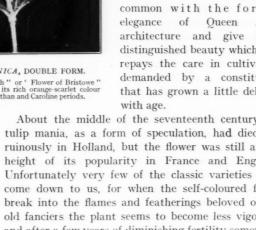
of the hybrid pink "Napoleon the Third," which has been nearly lost to cultivation, partly because its colour, so popular at the time of the Battle of Magenta, fell into violent disfavour (from which it has but just recovered) and partly because it has a bad habit of flowering itself brilliantly to death.

In the eighteenth century flowers were pushed into the background of fashion by the landscape gardeners and the artificial lakes and glades of Kent and Capability Brown were the obvious expression of the spirit of the time. Yet floriculture was carried on vigorously enough by those who could not or would not afford the upheavals of landscape gardening on the grand scale.

The artisans of the Midlands were raising the show polyanthus and, a little later, the exhibition auricula; docile plants whose exquisite symmetry clearly showed the ideal of beauty at which their cultivators were aiming. Old strains of the gold and silver-laced polyanthus are still in existence, but they are seldom seen nowadays, for the revived popularity of the plant is directed to the quite different beauty of the modern type with its opulent heads of rich, cloudily coloured flowers, and the smaller geometrically-designed flowers of the old show varieties belong obviously to another age. Round about Paisley the weavers were raising the black and white pinks, with a round centre and a

heavy, regular edging of dark purple, which are still known in a few old gardens as "Scotch pinks" and are well worth growing, in spite of the strong competition of modern varieties.

The Oueen Anne period gave a new name to the old double daffodil "Capax Plenus," which we know to-day as "Queen Anne's daffodil." And though there is no discoverable reason for the association, yet the regular tiers of triangular petals, which distinguish it at once from all other double daffodils, seem to have something in common with the formal elegance of Queen Anne architecture and give it a distinguished beauty which well repays the care in cultivation demanded by a constitution that has grown a little delicate with age.



About the middle of the seventeenth century the tulip mania, as a form of speculation, had died out ruinously in Holland, but the flower was still at the height of its popularity in France and England. Unfortunately very few of the classic varieties have come down to us, for when the self-coloured forms break into the flames and featherings beloved of the old fanciers the plant seems to become less vigorous, and after a few years of diminishing fertility sometimes dies out altogether. "It would seem," says Parkinson, "that this extra ordinary beautie in the flower is but as the brightness of a light upon the extinguishing thereof, and doth plainly declare that he can doe his master no more service and therefore with this jollitie doth bid him goodnight." But there



LYCHNIS CHALCEDONICA, DOUBLE FORM. Under the name of "Nonesuch" or Flower of Bristowe" this was much appreciated for its rich orange-scarlet colour in the gardens of the Elizabethan and Caroline periods.

This odd name is apparently our once well-known Young's 'Night Thoughts," borrowed into French as a simile for something particularly dark and lurid.



AN ELIZABETHAN RARITY.

The Plymouth strawberry (here seen with an old black pansy) was discovered in the seventeenth century by John Tradescant and considered "fit for a gentlewoman to weare upon her arm as a rartic instead of a flower."

are one or two of the old tulips which continue to carry on fairly vigorously, though every now and then they threaten to make their final farewell to the flower garden. The best known of them is probably "Zommerschoon," whose pink and white and sulphur yellow suggest the bright silk dresses and the striped sunlit awnings of the heyday of the Dutch Republic.

The Tudor and Elizabethan periods saw the beginnings of English gardening in a great wave of enthusiasm, but its two chief chroniclers, Gerard and Parkinson, described their plants with such catholic affection that it is not easy to pick out any flowers that are specially characteristic of the time; though for Parkinson "the Crowne Imperiall, for his stately beautifulness, deserveth the first place in this our garden of delights." Perhaps the double campions, such as Lychnis vespertina and Lychnis coronaria, which have long gone out of fashion, are typical in a way for the careless exuberance with which they break through their formal design. The more restrained Lychnis Chalcedonica was very much appreciated, perhaps because its rich orange-scarlet was a rare colour in the old flower gardens. It was known as the "Nonesuch" or "Flower of Bristowe" (i.e., Bristol, for many exotic flowers came into England at this time through the western ports and were first established in their neighbourhood). Britten and Holland, in their dictionary of English plant names, quote for it the pleasant, though rather literary, name of "Bridget-in-her-Bravery" from Lincolnshire, and Parkinson says, of the double form, that "as it is rare and not common, for his bravery it doth well deserve a master of account that will take care to keep and preserve it," a charge that would seem to have been faithfully observed only by a few cottage gardeners.

Apart from this quality of "bravery" the Elizabethans had a liking for fantastic and monstrous flowers which may or may not have been characteristic, though a parallel for the taste can be found in their drama. They were "curious lovers" of such things as the Plymouth strawberry, whose strange fruits were "pleasant to behold and fit for a gentlewoman to weare upon her arm, etc., as a raritie instead of a flower." In this strawberry the petals are replaced by a stiff green collar of bracts and the seeds are converted into bristles, which turn to a powdery crimson as the fruit ripens. It was found by John Tradescant at Plymouth in the garden of a woman who had brought it in from the woods with the common kind when she was restocking her beds in the autumn.

Another elegant monstrosity is the "Rose Plantain," whose fruit begins as a rosette of leaves which distantly resembles a green rose. Both the strawberry and the plantain are still with us and so (under the name of the Pantaloon Polyanthus) is the "Frantick or Foolish Cowslippe" which wears round each flower a ruff of leaves splashed in red, white, and green. Commoner, for it is to be found in not a few cottage gardens, is the simpler form with a plain green ruff, called "Jack in the Green," whose name recalls the figure in a cage of green branches who, till lately, used to dance through the streets of Oxford on May morning, collecting pennies and hopefully announcing the arrival of summer.

The Middle Ages had a mere handful or flowers in comparison with the rich variety that filled the gardens of the seventeenth and later part of the sixteenth centuries. Perhaps the periwinkle, with its dark green leaves and rather wistful blue flowers, may be taken as a representative. It was the flower of death, a garland for criminals on their way to execution, and matches that insistence upon mortality that runs, like a dark thread, through so much of the mediaeval poetry. Or, if the periwinkle is too much of our own time, we can take the sombre old columbines, whose double form may often be seen in illuminated manuscripts of the fifteenth century.

Old gardens offer a rich field for exploration which is, unfortunately, being narrowed by the activities of the builder; therefore no opportunity should be lost by those who are both antiquaries and gardeners of seeking out old garden plants and rescuing them from extinction. And if a reader should discover the silverstriped rosemary, "the Orange-tawnie Gilliflower," or any other lost treasure, it is hoped that he will make the good news public, perhaps in these columns.

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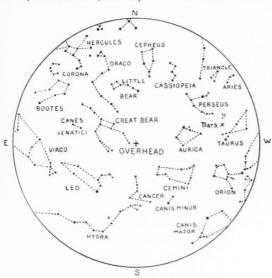
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Among the Stars: A Monthly Commentary.

THE HEAVENS IN MARCH. By J. A. Lloyd, F.R.A.S.

The chart herewith is intended to show the aspect of the principal constellations as seen from London on 1st March at 10 p.m. and on the 31st at 8 p.m. Planets visible this month



will be: Mercury, visible low down in the western twilight in the early days of the month. Venus is a conspicuous object in the west soon after sunset. Mars still continues to be visible in the evening sky: it sets about half-past one in the morning at the beginning of the month. Saturn is a morning star, but rises soon after midnight towards the end of March; it will be almost due south at dawn. The Zodiacal Light may be seen this month; it should be looked for in the west about two hours after sunset, especially towards the end of the month, when the absence of the moon will increase the chances of seeing it.

Public Interest in Astronomy.

In view of the public interest the coming eclipse is now attracting to astronomy, a suggestion in a recent letter to The Times from Dr. R. T. Gunther, of Oxford, deserves widespread attention. Following intimation that the question of erecting a planetarium in England was under consideration, Dr. Gunther pointed out that the cost of this instrument was prohibitive, and drew attention to an alternative method of popular instruction in astronomy. It may be well, therefore, he wrote, "to remind intending purchasers that, at his lecture on the Astrolabe, Professor Jenkin delighted an audience of science masters assembled in Oxford by showing them the stars moving in their courses by means of a special lantern slide, which could be made in quantity for about 15s., which means that for far less than the cost of one German planetarium a new and most valuable educational implement might be put at the disposal of every school in this country. Professor Jenkins' Oxford

Astrolabe, based on an ancient instrument of Hipparchus as transmitted to us by the Arabs and by Chaucer, can be used "to know every tyme of the day by light of the sonne, and every tyme of the night by the fixed sterres," and for many other purposes. These instruments would, moreover, serve as valuable models from which any scholar armed only with a protractor and a pair of compasses can construct for himself one of the most valuable educational instruments that the world has ever seen."

The Ether-Drift Problem.

News comes from America of yet another attack on the problem of ether-drift. Most people know that in 1887 the two physicists Michelson and Morley set out to obtain an absolute proof of the earth's motion in space, irrespective of the proofs afforded us by our senses. They made use of a principle of optics known as "interference," and their apparatus was of an elaborate and extremely sensitive character. But, contrary to their expectation, the experiment was a total failure, and they were unable by its means to obtain any evidence of the earth's motion through the ether. Out of an attempt to explain the failure of this experiment arose the Theory of Relativity. The experiment was repeated from time to time, by Morley and Miller, by Sir Oliver Lodge (using a different method), and others, always with the same result. Some time ago, however, the scientific world was startled by the announcement that Professor D. C. Miller, repeating the experiment at Mount Wilson Observatory, California, had found an ether-drift of ten kilometres per second. Many persons then considered that Miller had dealt Einstein's theory its death-blow. Now however, the experiment has been performed by Roy J. Kennedy, using apparatus having four times the sensitivity of that employed by Miller. This latest attempt was made both at Mount Wilson and at the Norman Bridge Laboratory, Pasadina, but at neither station could any trace of drift be detected. So the famous theory of Einstein is once more

Sir Isaac Newton.

It seems fitting that some mention should be made here of the celebration of the bicentenary of the death of Newton, which will take place this month. Astronomers and physicists from all parts of the world will journey to Grantham this month to pay their respects to the memory of the greatest mathematical genius who ever lived. The celebration will be held from Friday, 18th March, to Sunday, 20th March. Friday's ceremony will take the form of a civic reception by the Mayor of Grantham at the Guildhall. On Saturday addresses will be given on the work of Newton in various departments of science, each address being delivered by an eminent authority on that particular branch. For instance, the Astronomer Royal will speak on "Newton's Work in Astronomy." In the afternoon there will be a pilgrimage to Woolsthorpe Manor, Newton's birthplace, and a visit to Stoke Rochford, where a lecture will be given by Mr. C. Turnor, on "Newton's Countryside," while in the evening a celebration dinner will be held at the George Hotel, Grantham, at which Sir J. J. Thomson, O.M., F.R.S., will preside. On Sunday the bicentenary service will be held at the Parish Church, Grantham, the preacher being the Lord Bishop of Birmingham, Dr. E. W. Barnes, M.A. Sc D., F.R.S.

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The Month's Wireless Developments.

HOW AMERICA IS REACHED. By F. H. Masters.

So much interest has rightly been displayed in the telephonic service opened to the public between this country and the United States at the beginning of the year, that now the first excitement has subsided it may be of interest to trace the progress of a call between a subscriber in, say, London and another in New York.

This progress may be divided into three stages: The connexion between the subscriber and the Rugby high power station at this end, the wireless link across the Atlantic between Rugby and the American receiving station at Houghton, and the connexion between Houghton and the wanted subscriber in New York or elsewhere in America. Of these, only the second is purely wireless, for in the first and third ordinary land lines are used for communication, with the existing exchange equipment and subscribers' instruments.

Two Channels for Speech.

It must also be noted—a very important point—that unlike land telephony the conversations of the two subscribers do not follow the same channel. In every telephonic conversation, of course, each participating subscriber is in turn a transmitter and a receiver, but while in land telephony the same pairs of wires are used for both purposes, and it is only at the actual subscribers' instruments that any splitting up occurs, in wireless telephony different bands of the ether are, so to speak, used for transmission and reception, and the combination does not take place until London or New York is reached, as the case may be. Splitting up, as before, occurs again at the subscribers' instrument, but by then the communication is no longer strictly speaking wireless. While, therefore, when a London subscriber speaks to a New York subscriber the current impulses generated by his voice go via Rugby and Houghton to New York, the current impulses generated by the voice of the called New York subscriber pass via Rocky Point and the Wroughton receiving station to London. Both at London and New York the two sets of voices are combined, so that at each end the appropriate land lines can be used in the ordinary way.

Coming to the call proper, when a London subscriber litts his receiver and asks for "American service," he is connected by the operator on his own exchange by the usual switching equipment to a special operator in the London Trunk Exchange. This operator, having ascertained the subscriber's requirements, establishes communication-via the land line to Rugby, the wireless link and the appropriate line in America-with her "opposite number" on the British service exchange in New York. This operator obtains the subscriber required in the ordinary way via the local exchange, and informs the London operator, who in turn re-establishes communication with the calling subscriber and makes the necessary connexion. The procedure from the traffic point of view is therefore closely analogous with that necessary to make, say, a London-Paris call with the added advantage that there is no language bar. Nevertheless, there are certain differences of nomenclature, though these have been largely overcome by the wise policy of interchanging operators between this country and America. Another modification compared with the ordinary service is that it is possible to call an actual person instead of only a

number. This saves delay during the precious six minutes, and also money, as the full charge is not made unless the actual person wanted can be obtained.

VOICE AND PERSONALITY TESTS. By Edward Liveing, M A.,

Manchester Station Director, B.B.C.

The voice and personality tests conducted from the Manchester Station and S.B. to all stations on 17th, 20th and 21st January brought in 4,760 coupons and letters. Letters came from all parts of the British Isles and also from Brussels, Amsterdam, The Hague, and ships at sea. Persons in nearly every class and walk of life figure in the correspondence, including school-masters, teachers of music, clergymen, secretaries, psychologists, engineers, mechanics, housewives, miners, civil servants, clerks, university men and students, blind persons, and merchants. In all, nine persons took part in the tests—a detective-sergeant, a lady secretary, a clergyman of the Church of England, a lady buyer and controller of the tailoring department of a large business firm, an army officer, a schoolgirl, a judge, an electrical engineer, and an actor, the last being Mr. George Grossmith.

Approximately 385,360 facts have to be sifted out and classified before any statements can be made by Professor Pear, who conducted the tests and is making the investigations. It is, therefore, rather premature for me to draw any inferences in a scientific paper such as Discovery. It may interest readers, however, to know that speakers were chosen who were not just stereotypes of their professions or occupations, but in spite of this many very accurate answers were given, more particularly with regard to the occupations of the clergyman and the actor. About 65 per cent of the answers gauged the profession of Canon Dams, the clergyman, accurately, and about 85 per cent that of the actor, Mr. Grossmith. One listener stated that in regard to speakers I and 7, he felt that they were one and the same person, but that that person had adopted a different accent for the two readings. This is a rather interesting example of characteristics acquired through environment and occupation being shown in the voice, for speaker I was a detective-sergeant accustomed to giving evidence in court, and speaker 7 a county

Age proved a stumbling block to many listeners, but it may possibly be inferred from the eventual classification that the average listener can guess the age of an adult person from his voice to within fifteen years. A great variety of guesses were made at localities of birth and localities subsequently affecting speech, and the results of the classification of these answers, whether positive or negative, should be decidedly valuable to the phonetician. A large number of listeners accurately gauged the university which had influenced the speech of the clergyman, who was educated at Cambridge. It might be inferred from this fact that there must be a much more pronounced difference, than has been thought to be the case, between the accents of men educated at the two oldest universities. These voice and personality tests originated from suggestions contained in a letter from an Isle of Man listener, Mr. E. A. Blair of Douglas, and have shown the interesting possibilities of the wireless medium for effecting a mass application of scientific experiments on a greater scale than could otherwise be obtained.

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Correspondence.

THE CANADIAN MUSK PLANT To the Editor of DISCOVERY.

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In reply to Mr. Hampton's inquiry in your January issue about the musk plant-during the coming spring and summer I shall be glad to make a careful study of this plant and will report the results to you.

The musk plant grows here in profusion, and it prefers rock crevices facing the south. It is at its best in wet places, but even in dry localities the blossom grows very large, though the stem and leaves, are wiry and small. It favours rocky bluffs exposed to the most violent storms, and generally just above high-water mark, hence it is frequently deluged with sea-water spray. The rocks here are mostly limestone. I have not yet found out whether it has any scent or not.

I should be glad to send Mr. Hampton some of last year's roots if he can suggest a way to pack them and keep them alive, as possibly something might develop from cross fertilization to improve or regain the scent. I presume it is allowable to ship plants into England? The U.S.A. prohibit them, fearing certain diseases.

Yours truly,

Kynquot, West Coast,

H. V. NEAVE.

Vancouver Island. 20th January, 1927.

Dr. F. A. Hampton writes:-" I very much appreciate Mr. Neave's interesting notes on the musk plant, and his kindness in offering to send roots; but, since we know that at least the majority of musk plants in Vancouver are scentless, it would hardly be worth his trouble to send plants whose flowers had not been examined. The importation of living plants into England is not absolutely proscribed, but is made difficult by various regulations, and it would therefore be better to rely upon seeds. I look forward with interest to the results of Mr. Neave's examination of the plants in his neighbourhood."

The following was contained in a letter addressed to Dr. Hampton by a correspondent in Duncans, British Columbia:

"I have known Mimulus Moschatus very well during the past twenty-seven years. It grows in dried-up ponds in this district where there are no coarse grasses, and there is always a root or two in my pond. The sweet musk that the servants had in the days of my youth had a delicious scent. British Columbian musk has none, or it is hardly noticeable, but as it is under water for three months and baked dry three months in July, August, and September, it hasn't much chance of being scented.'

A KEY TO SPECIALIZED INFORMATION.

To the Editor of DISCOVERY.

Just as the practical utility of a book is impaired by the want of an index, so the vast aggregation of knowledge that has been built up, and is in many cases being added to day by day, is largely lost to mankind owing to the lack of a master-key to its whereabouts. Throughout this country there are numerous centres of specialized knowledge and experience of the most varied description, whose existence has only to be known for them to prove of the greatest service to the world in general. It is with the object of bringing these to light and recording their salient features in concise form, that the Association of Special Libraries and Information Bureaux is

compiling a directory under the editorship of Mr. G. F. Barwick, late Keeper of Printed Books at the British Museum.

At a meeting held at the Royal Institute of British Architects on 23rd February, Mr. Barwick spoke on the present position of the work, which has now been in progress for eight months. It has been decided to go forward with the printing of a first edition of the directory at midsummer of this year, but much still remains to be done. It is recognized that completion in any one subject is well-nigh impossible in so short a time. It would, however, greatly further this end if libraries, organizations, firms, or individuals which have special information on any subject, and which have not yet been in touch with the editor of the directory, would communicate with him at the earliest moment. This applies equally to the various bureaux of information established under one name or another in different parts of the country.

Yours truly,

38 Bloomsbury Square,

G. W. KEELING.

Secretary

London, W.C.1 Association of Special Libraries and Information Bureaux.

> "DORTON SPA." To the Editor of DISCOVERY.

SIR.

Following the appearance of my article on "Dorton: A Forgotten Spa and its Water," in your February issue, the Westminster Gazette of 7th February published a column from a special correspondent under the title "British Spa awaiting Development-Lost at London's Back-door-Better than Buxton." In this contribution reference was made to my article in Discovery, and some figures from my analysis were quoted which apparently suggested that I agreed with the sensational heading in the Westminster Gazette. I sent a correction to the Editor of that journal, but as space has not vet been found to correct a wrong impression, perhaps you will allow me to do so in Discovery.

So far from being a spa awaiting development, I am of opinion that any attempt to resuscitate it, as suggested by this correspondent, would be foredoomed to failure, for the causes which prevented the original spa from being a lasting success still remain

The spring is almost as inaccessible (except to private motors) as it was in the days when Dr. Willcocks Sleigh wrote his misleading note that Dorton with "its Italian climate" was "within a morning's drive of the metropolis." "residences for the nobility and gentry" still remain unbuilt, and the Dorton Spa Rural Hotel has vanished with the spa.

The days are past when the medicinal qualities of a spring were sufficient in themselves to turn an obscure little village into a prosperous town, and not even the judicious advertisement of cures alleged to have been effected by the water would now bring the succession of visitors required to make a spa

It is true that the composition of the water is remarkable. as is shown by my analysis published in Discovery, but many medicinal properties were claimed for it which are not justified by the facts. For instance, Dr. Sleigh, writing in 1842, said that "a young lady who had taken iodine in London a year since" stated that it produced the same effect as the Dorton water, and he accounted for the absence of iodine from Professor Brande's analysis by pointing out that it was well known that iodine was acted upon by light. I am afraid that one cannot accept a young woman's memory of the physiological action of a mixture of salts as a trustworthy test for iodine, any more

than one can accept Dr. Sleigh's explanation of the disappearance of the iodine. As a matter of fact, there is no iodine in the water to-day, either free or combined.

Many of the other claims made for the efficacy of the water are equally open to criticism, and although the water is rich in iron, it has the drawback of containing free sulphuric acid. This may not be injurious to most people, but it is questionable whether a water in which the free mineral acid may reach nearly one per cent should be taken indiscriminately. Little attention appears to have been paid to this point by the pioneers of the spa, Dr. Knight and his successor Dr. Sleigh, for the former actually recommended the addition of more sulphuric acid to clear the water, and the latter was silent on the point.

A depot for the sale of Dorton water was established in London, and had the spring possessed the properties attributed to it, there was no reason why it should not have continued to produce its alleged wonderful cures up to the present time, but it is significant that the demand for the water stopped when the spa was abandoned.

I am, dear Sir,

Yours faithfully,

137 Victoria Street, S.W.1. C. AINSWORTH MITCHELL. 17th February, 1927.

ARTIFICIAL PRODUCTION OF SPEECH. To the Editor of Discovery.

SIR

With reference to the very interesting article by Sir Richard Paget, published in January, may I ask if the models for the production of vowel sounds could be used to give a visible signal to the deaf (i.e., the born deaf) when they had produced a correct vowel sound. If it could act as a resonance chamber that would on excitation make a sensitive flame flare, then the model would be useful in the difficult job of oral training of the deaf. Sir Richard's last paragraph puts the whole plan of campaign for spelling reform in a nutshell. He will be interested to hear that the plan of learning to read by commencing with the alphabet of the International Phonetic Association has been practised in all four of the demonstration schools attached to the training colleges for teachers, at various times since 1018.

Yours faithfully,
The Academy,
Kilsyth, Glasgow.

Yours faithfully,
JAMES ALLAN.

Sir Richard Paget is at present away on a lecturing tour in America, but will no doubt read our correspondent's comments with interest on his return.—Ed., Discovery.

Book Reviews.

The Cleaning and Restoration of Museum Exhibits. Third Report upon Investigations conducted at the British Museum. (H.M. Stationery Office. 5s.).

Probably few of the many people who visit the public museums, and even of those who go there on more serious quests than the satisfaction of a laudable curiosity, give any thought to the importance of the work which is constantly being carried on behind the scenes. Some idea of this is to be gathered from this volume with its numerous illustrations in collotype and its brief explanatory survey. The volume, which is intended primarily for the use of curators of museums, private collectors, and others who have in their keeping or possession objects of archaeological or artistic interest, may well reach a wider public of less scientific lovers of antique curios. The experiments described cover a wide range. Hints are given as to the best methods of mending broken pottery, and as to the preservation of so-called "worm-eaten" wood. The helmet of the Black Prince, which hangs above his tomb in Canterbury Cathedral, was doctored with a view to arresting corrosion by rust, and the prince's cap of maintenance, in leather, painted in red and gold which had become almost everywhere hidden by the dust and grime of ages, was restored to something more than a semblance of its original design and shape. The bronze case for a mummified fish in the British Museum was successfully treated for the removal of a closely adherent incrustation which entirely concealed the fine detail work now visible on the fins and scales. To the average person the treatment of old prints and drawings is perhaps one of the most interesting subjects with which the volume deals. Fox marks on engravings, a very familiar defect, are subjected to cautious treatment with bleaching powder and dilute hydrochloric acid or, in cases where the presence of water is undesirable, with hydrogen peroxide vapour. The use of this ethereal solution is well exemplified in a number of colour prints by William Blake which were cleaned up brilliantly and rapidly by means of this reagent. The discolouration was largely due to the tarnishing of the flake white used, and in many cases this was accentuated by the poor quality of the gelatine or glue employed by Blake in the composition of his pigments. Fine reproductions in colour of many of these engravings appear in Mr. Laurence Binyon's recently published book "The Engraved Designs of William Blake," and an illuminating comparison can be made between these and the reproductions in the present volume of the same prints before restoration.

C. E. H.

Accidents to Aeroplanes involving Flutter of the Wings. Report of the Accidents Investigation Sub-Committee. (H.M. Stationery Office. 1s. 3d.).

The problem of "flutter" in aeroplane parts is likely to become of increasing importance as the speed of aeroplanes is increased, and some of the occurrences affecting flutter of the wings were referred to an official accidents sub-committee for investigation. The whole problem of flutter and vibration has proved to be a much more complex problem than was at first realized, and a general investigation has been started which will take more than a year to complete.

Some definite conclusions were reached at an early stage in the investigation, and these have been put together in the present report. The aeroplanes in question (which are not now used in the Royal Air Force), developed an unusual amount of oscillating movement of the wing tips of considerable magnitude accompanied by excessive vibration of the whole machine. The apparent movement of the wing tips was about an inch at rates which have been estimated between 400 to 1,000 per minute. It would appear that there are various means of overcoming the vibration difficulty or of postponing its occurrence to a higher speed, as, for example:—(1) by the movement of the point at which aileron is controlled; (2) by

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arranging that the C.G. of the aileron should be on the hinge; (3) by an attachment designed either to limit the motion of the spar or to increase its stiffness.

Some theoretical work on the subject, and some of the conditions as reproduced experimentally at the Royal Aircraft Establishment, are reported in appendices.

The Pulse of Progress, including a sketch of Jewish History. By Ellsworth Huntington, with a chapter on Climatic Changes by G. C. Simpson. (Charles Scribner's Sons. 21s.).

This is a composite book, even more so than its title indicates. Chapters VI-X are a convenient restatement of the researches and conclusions of Dr. Huntington on the effects of climate in men's doings, both now and in historical retrospect. But as usual with Dr. Huntington's writings, they are not restatement merely; they review current inquiries, such as those of the New York Ventilation Commission, and the Committee on the Atmosphere and Man of the National Research Council, and Dr. Dexter's "Weather Influences," and incorporate many fresh and ingenious suggestions, such as the significance of storms and abrupt changes of weather, quite apart from general averages of temperature and humidity. And there is included a reprint of Dr. Simpson's recent article in the Nineteenth Century and After on "Climatic Changes," in place of Dr. Huntington's own projected chapter on this topic.

Prefixed to this more systematic section are five less connected essays, on the "Rhythm of Progress and Decay" among animals as well as mankind; on the "Handicap of Poor Land," a subject which necessarily recurs in every question of migration and redistribution of people: on "Migrations in the United States," dealing with the movements, from state to state, of individuals following various selected occupations; on the Sifting Power of Cities," in which an important distinction is revealed between the function of the larger city and the smaller regional or district centre, a point which should be kept in mind in dealing with earlier historical situations, as well as with modern statistics; and on the "Dominance of Nomads," in which reasons are suggested why the Nomad Pastoral should be capable of producing the widespread effects which follow his emergence from his desert home, only men of exceptional endurance, initiative, self-reliance, and therewith ability to subordinate themselves and co-operate in large schemes under a recognized leader being capable of maintaining themselves in the austere conditions of grass-land life.

At first sight, rather detached from all this, is an analytical sketch of the history of the Hebrew people, but it falls into place as an attempt to apply Dr. Huntington's philosophy of history to a concrete instance; and as he has explained in the preface, it was a choice between many detached and sketchy illustrations, and a single example more thoroughly worked out Without wholly disregarding the conclusions of modern criticism of the Biblical record, Dr. Huntington finds the traditional history so full of graphic and especially of geographic detailfor example, his analysis of the "Plagues of Egypt" as accompaniments of an abnormally low Nile-that he is content to follow it closely, even to the point of attributing the early emergence of strong tribal or national characteristics to the indigency of the personal Abraham and his family. discussion of the successive crises of selection and segregation through which the early Hebrews and eventually the Jewish survivors of them passed is full of suggestive matter, especially his emphasis on the point that each fresh segregation was accompanied by severe elimination of the unfit, either by death or by mere loss among surrounding peoples. In this sense,

indeed, the history of the Chosen People is also that of the Lost Tribes. This is most strikingly shown in the explanation offered of the substitution of the mediaeval and modern type of Jew, averse from violence, and pursuing his objects by quite other means, subservience and superior cunning, for the pugnacious, self-conscious, self-assertive type represented by the earlier heroes of the nation.

Less fully worked out, inevitably, but no less suggestive, is the single chapter on the national suicide—as it appears to Dr. Huntington—of the last few years in Russia. For while admitting the justifiability of the Bolshevist experiment—which in its object he compares instinctively with recent "Labour" legislation in Australia—he is able to put his finger on the factors which he thinks foredoom it to failure, and to replacement by another regime of exploitation by alien immigrants.

There are a few odd slips and misconceptions in details, but the book is one which deserves careful reading, and suggests many problems for further examination, on the lines illustrated above.

J. L. Myres.

Essays in Popular Science. By Julian Huxley. (Chatto & Windus. 16s.).

The manifold developments in modern science require continually the production of fresh agencies in the diffusion of new knowledge. Every scientific discovery may be stated in abstruse terms or may be couched in language which the intelligent layman can understand. A double duty therefore rests upon every scientific man, to aid in the discovery of new facts and also in the process of building them into the structure of scientific thought and the broader tabernacle of popular conceptions. It is not given to every scientific man to function conspicuously in the second process, but certain it is that the popularizing and diffusion of science in the best sense is a process which in the long run is essential to the continuous advance of scientific research.

Professor Huxley's easy style and powers of exposition should give his writings a high value in the process of diffusion of scientific knowledge. We know of nothing which is more likely to sustain the interest of the intelligent layman in what is now being thought and done in various fields of biology than the book before us. The eighteen essays here brought together have been written on various occasions, and several are here published for the first time. Beginning with heredity and the inheritance of acquired characters, we go on to essays on the determination of sex and Why do more boy babies die than girls? "The control of the life cycle," which first appeared in the English Review, refers to a wide range of experimental work on this subject, and touches upon some of the philosophical questions of time and personality involved.

The essay on Thomas Henry Huxley and religion, reprinted from *The Modern Churchman*, revives the part which the author's grandfather played in the struggle for plain thinking on these subjects in a previous generation. Three short articles, "Birds and the territorial system," "An hour's Psychology" and "Evolution and Purpose," each makes its appeal in a brief discussion of a widely different biological problem. The last two chapters, occupying over a third of the book, are concerned with the frog. In "The Frog and Biology" are woven together many well-known facts and an abundance of recent discovery relative to the thyroid and metamorphosis, the pituitary and pigmentation, as well as other aspects of batrachian existence.

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Elementary teachers of zoology could nowhere find a better short statement of the modern work on ductless glands and its significance.

In these essays we have clear and simple expressions without inaccuracies, and the individual with any biological contacts at all will find many of them full of interest.

R. RUGGLES GATES.

Primitive Culture in Italy. By H. J. Rose, M.A. Methuen's Anthropological Series. (Methuen & Co. 7s. 6d.).

Italian prehistory presents many problems which the data available from archaeological research, at present, are wholly inadequate to solve even when assisted by the notable contribution of many distinguished workers on the philology of the Italic dialects. Professor Rose, however, is not concerned primarily with the finer distinctions between the early races and cultures; it is enough for his purpose that the successive strata of culture for which he finds evidence from other than archaeological sources are corroborated by remains which date from a Stone, a Bronze, and an Iron Age. Postulating, or deducing from the archaeological evidence, a certain type of material culture, religious belief, and social organization as appropriate to these stages of civilization, Professor Rose's object is to show that certain features in Italic and especially Roman culture of later times, when analysed, are explicable only as derivatives or survivals, from one or other of the phases of prehistoric times. Greek and Etruscan influences are expressly excluded from the inquiry. In all the provinces of life here passed under review-religion, priests, the kingship, family and clan, and the law-religion and magic perhaps provide the most illuminating material. This, no doubt, was to be expected from the strongly conservative element in Roman religion. In this department Professor Rose is certainly most original and his critical acumen most acute. He shows that apart from anthropomorphic conceptions derived from Greek sources, the Roman deities were essentially mechanisms for securing on certain specific occasions the direction of Mana, the primitive conception of power or "virtue," by magical means into channels profitable to the community. The author has supported his argument with a vast erudition; but he writes with an eye to the needs of those who are not specialists. The result is a book of which the interest is absorbing and more than sufficient to overcome any unfortunate memories, if any there be, of a less auspicious introduction to the manners and customs of ancient Rome.

E. N. FALLAIZE.

College Geography. By R. PEATTIE. (Ginn & Co. 128. 6d.). The charge which is often brought against geography of being dry and uninteresting could not be made if the subject were generally taught on the lines of this book. There is no attempt to dwell exclusively on either the physical processes that are fashioning the surface of the earth or production and trade. The author takes a broad view of geography, and escapes the charge of making his subject merely an adjunct to commerce and business. He views the earth broadly as the home of man and not only as his market-place, and his treatment is a survey of the chief types of environment in order to show how each presents its own problems to man. He has not written a textbook of regional geography, but a general introduction to the subject, always keeping in view the educational value of the study of relationships between the various phenomena that make up the environment in which we live. In this way the study of geography is invaluable in counteracting the narrowness of outlook which is the inevitable result of specialization in one or other branch of learning at an early age. For that reason modern synthetic geography finds little favour among analytical specialists who profess, often with sincere conviction, that they can see no value in the study.

As the title implies, the volume is American, and evidently designed for the higher forms of secondary schools. While the plan and fulfilment on the whole are good, there is room for a little criticism. Mr. Peattie warns his readers against the danger of generalization. There is not necessarily a causal relationship between two phenomena occurring in the same locality. The inertia of the peoples of India is not proved to be due to the warm moist climate. Yet he says that moisture and heat make the Amazonian forests enervating to such an extent that they have a comparatively slight population. It would be true to say that the climate causes a form of vegetation that allows little scope for human settlement and food production. Again, it is an assumption to say that at one time there was an ice-free route between Iceland and the nearest shores of Greenland, or that the Eskimo attacked and killed the old Norse settlers in Greenland who had not already left owing to increasing severity of climate. Neither statement is proved; the latter is probably wrong. The book, however, is to be commended, but its value to English students is reduced by the tendency to select examples of geographical processes from America. There are excellent inustrations and useful bibliographies.

R. N. RUDMOSS BROWN.

Manual of Plant Diseases. By F. D. HEALD. (McGraw-Hill Publishing Co. 35s.).

This volume is intended to serve as a Jeneral manual for use in classes in general plant pathology, and aims at covering the whole field of the subject, with the exception of methods of culture and of technique in general. The principles of disease control are not treated separately, but control methods in use are described and discussed under each disease. It is divided into four sections. The first is introductory, and includes a general account of the symptoms occurring in plants. The second deals with non-parasitic diseases, and an unusual proportion of space is devoted to this important and frequently much-neglected subject. The third section treats of virus diseases, and the fourth of diseases due to parasites, and includes a chapter on parasitic seed plants and one on nematodes. In the parasitic section the fungal diseases are arranged, not under their host plants, but in the taxonomic sequence of their causal agents. This arrangement has its practical inconveniences, which are partly met by a reasonably full index; but it helps to develop the student's usually scanty knowledge of systematic mycology, of which subject as much is given as he is likely to require

The book is designed primarily for use in America; the diseases selected for detailed description are those of most importance there, and a brief account is given of the development of plant pathology in the United States; but it fills a gap there which is not so adequately and conveniently filled in this country, and it may be recommended as a well-illustrated, clearly written, accurate, and for its size, comprehensive manual, useful both to teachers and to students. When so much compression is essential and every illustration might be made of value, it seems a pity to include such figures as Nos. 2-6 inclusive, which serve no useful purpose.

J. HENDERSON SMITH.

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